Bulletin
of the
Torrey Botanical Club

VOLUME 58

FOUNDED BY WILLIAM HENRY LEGGETT 1870

NEW YORK
1931–1932

Published for the Club
GEORGE BANTA PUBLISHING COMPANY
Menasha, Wisconsin

CONTENTS

Dates of publication

No. 1, for January, pages 1–66, issued 17 September 1931.
No. 2, for February, pages 67–126, issued 1 October 1931.
No. 3, for March, pages 127–202, issued 22 October 1931.
No. 4, for April, pages 203–276, issued 3 November 1931.
No. 5, for May, pages 277–344, issued 21 November 1931.
No. 6, for June, pages 345–404, issued 11 December 1931.
No. 7, for October, pages 405–464, issued 24 December 193
No. 8, for November, pages 465–516, issued 24 December 1
No. 9, for December, pages 517–562, issued 16 January 1932.

Physiological effects of boron on wheat

HELEN S. MORRIS

(WITH PLATES 1–2 AND FOUR TEXT FIGURES)

In recent years considerable work has been done in an attempt to discover the rôle which the element boron plays in plant metabolism, and the results of this work may be divided into three main groups. These consist of observations on the necessity of the element in minute quantities for the normal and healthful development of plants, its toxicity in higher concentrations, and finally a so-called stimulating effect which it exhibits when present in optimum concentration.

The necessity of boron for the healthful development of plants has been demonstrated by a number of authors working on various species. Mazé (1919) stated that boron, fluorine, and iodine were necessary for the complete development of corn, and that the absence of boron resulted in more immediate and more serious injury than did the lack of either of the others. Warington (1923) demonstrated the necessity of boron for the broad bean and clover and remarked on the similarity existing between the rôle of boron in plant life and that of vitamines in animal life. This similarity was not based on chemical nature, but on the fact that both substances were necessary for healthy development, both were needed in minute quantities, and both had to be supplied continuously throughout the life of the organism. Brenchley and Thornton (1925) showed that boron was necessary for the formation of nodules on the roots of *Vicia faba*. The suppression of the characteristic root tubercles in boron-deficient solutions was found to be due not to lack of infection, since the activities of the nitrogen-fixing bacteria were not greatly curtailed in the absence of this element, but to the fact that the vascular strands of the host degenerated. As a result, the bacteria were deprived of their accustomed nutritive material, and were forced to parasitize the meristematic cells in the nodule, thus effectually preventing its further development.

Brenchley and Warington (1926) found that *Vicia faba*, when deprived of boron, not only failed to develop root nodules, but also exhibited apical injury, and died prematurely. Concentrations of boric acid containing 0.07 ppm. of boron or more were sufficient to produce healthy apical growth, but the supply had to be constantly renewed. Warington (1926) studied the effects of boron deficiency on the anatomical structure of *Vicia faba* and found that if boron were not supplied in quantities greater than 0.08

ppm., the root system became thick and stunted, the flower buds withered and dropped off, and the injury traveled down the plant from the apex toward the root. There was a breaking down of cambium and all meristematic tissue, as well as of phloem, xylem, and ground parenchyma. Sommer and Lipman (1926), in a comprehensive study of mustard, flax, Castor bean, sunflower, and barley, supplied photographic evidence of the general necessity of boron for higher green plants. By removing the seed remnants from the young seedlings they demonstrated that boron was needed early in the development of the plant, but that 0.5 ppm. of boron was adequate for the first few weeks and in some cases for the life of the plant. Swanbeck (1927) and McMurtrey (1929) found that boron was essential for the development of tobacco. Plants deprived of it exhibited typical apical withering and a tendency to form new branches in the axils of the leaves. These abnormal branches withered almost as soon as they were formed. Johnston and Dore (1929) demonstrated the necessity of boron for tomatoes grown in culture solutions. The plants grown in boron-deficient solutions showed a characteristic apical injury as well as unhealthy root development and degeneration of conducting tissues. Haas (1930) reported that boron was essential for the growth of citrus trees, and that trees deprived of it developed abnormal symptoms within two years but were capable of recovery when traces of boron were added. Johnston and Fisher (1930), by placing tomato plants in boron-deficient solutions at the time of blossoming, demonstrated that the element was essential for fruit setting. Only one-fourth as many fruits set in the boron-deficient solutions as in the controls, and these fruits were covered with darkened areas of dead cells.

The toxicity of boron in higher concentrations has been frequently demonstrated, both by laboratory culture methods and by field experiments. Agulhon (1910) found that wheat seeds could be considerably retarded in germination if they were soaked for six hours in a solution containing five grams of boric acid in a liter of water (850 ppm. of boron). His work with various agricultural plants brought out the fact that the toleration range varied with individual species and with experimental conditions. Thus wheat grown in water cultures was not poisoned by solutions containing less than 20 ppm. of boron, whereas wheat, oats, and radishes grown in sand cultures showed toxic effects with concentrations as low as 5 ppm. The greater toxicity of boron in sand cultures he believed to be due to surface concentration effects resulting from evaporation. There was greater toleration of boron in soil than in sand, a fact which he attributed to the possible fixation of boron by the calcium in the soil in the form of insoluble borates. In the soil cultures, differences in toleration were exhibited by different plants, corn being poisoned by concentrations above

10 ppm., radishes by concentrations above 25 ppm., and peas and vetch apparently capable of withstanding concentrations up to 50 ppm.

A similar variation in toxic effects was observed by Brenchley (1927), who found that barley was definitely poisoned by 4 ppm. of boron and was sensitive to concentrations as low as 0.4 ppm., whereas peas could endure concentrations of from 20 to 40 ppm. Her results indicate a general toxicity of boron down to a concentration of 20 ppm., and in many cases lower concentrations. Swanbeck (1927) reported that a concentration of 68 ppm. of boron as boric acid was toxic to tobacco grown in nutrient solutions. The work of Collings (1927) on the soy bean presented additional evidence for the toxic effect of boron on germination of seeds and also for the greater toxicity of the element in sand than in soil cultures. He reported a similarity in the toxicity of potassium borate, sodium borate, and boric acid that indicated that the concentration of boron in the culture solution was the controlling factor in toxicity. Johnston and Dore (1929) in their work on tomatoes reported toxic symptoms with solutions containing 5.5 ppm. of boron. Haas (1929) found that 6 ppm. of boron was toxic to lemon and orange seedlings grown in Hoagland's solution, and that concentrations above 50 ppm. in irrigation water were highly toxic to lemon trees grown in soil. An ash analysis of the affected plants showed a decrease in calcium content and an increase in potassium content compared with the control plants. He reported that ferric sulphate had an ameliorating influence on this boron poisoning and suggested that the effect might be of a catalytic nature or due to precipitation.

A great number of field experiments have also been reported on boron toxicity. These experiments have largely been stimulated by the destruction of citrus orchards by boron impurities in irrigation water (Kelley and Brown, 1928), and by the failure of the potato crop in 1919 as a result of a borax impurity in the newly exploited potash fertilizers obtained from the Searles Lake deposits (Blair and Brown, 1921). Blair and Brown (1921) found that the potato yield is decreased to one-half by an application of 100 pounds of borax to an acre, to one-fourth by 200 pounds, and to one-twentieth by 400 pounds. They also reported that an application of 5 pounds per acre seriously retarded the growth of corn. Skinner and Allison (1923) found that cotton was seriously injured by an application of 20 pounds to an acre. Skinner, Brown, and Reid (1923) reported that corn and beans were more susceptible to borax injury than were potatoes, and that an application of 10 pounds to an acre was sufficient to decrease the germination of bean seeds by 50 per cent.

The symptoms of boron toxicity in general differ from those due to its absence, in that the signs of injury appear first at the base of the plant and

travel progressively upward, whereas in boron deficiency the first signs of injury occur at the meristematic apices. Toxicity is evidenced by the destruction of chlorophyll, and also crinkling, burning, and marginal curling of leaves. Haas (1929) reported symptoms of toxicity in lemon to consist of chlorosis, marginal burning, mottling, and the formation of resinous spots on the ventral surfaces of the leaves, followed by their early abcission. He stated, however, that there were no changes in the vascular anatomy as reported by Warington (1926) for broad beans grown in boron-deficient solutions. Collings (1927) reported similar symptoms for the soy bean, remarking that, although the injury advances progressively up the plant, it never appears in the young, actively dividing tissue.

The data are less uniform in regard to stimulation effects which boron produces when present in optimum concentrations. Agulhon (1910) found that there was a marked increase in the growth of higher plants in definite optimum concentrations of boric acid. He described the effect as represented by a curve, at first ascending under the influence of minute concentrations, up to an optimum concentration, then descending under the influence of toxic concentrations to a lethal concentration at which any growth is impossible. He found that the optima differed with different plants, that for wheat lying between 2.5 and 10 ppm. of boron. No definite optimum could be found for vetch, all the concentrations which were non-toxic producing equal growth. Because of the low concentrations at which optimum growth occurred, Agulhon classed boron as a catalytic element.

The curve described by Agulhon has been substantiated by the work of later investigators. For a number of plants, definite concentrations of boron have been found to produce a marked increase in growth, irrespective of whether or not the element has been proved to be essential. These concentrations may be considerably higher than those which are sufficient to prevent visible symptoms of boron deficiency. Such concentrations have frequently been called stimulating; but whether this phenomenon is truly stimulation, by which we imply supra-normal metabolism, or rather simply a high growth rate due to an optimum concentration of a nutrient substance, is questionable. Brenchley (1927) reported that peas exhibited optimum growth in 2 ppm. of boron, and yellow lupines in 3.5 ppm. Brenchley and Warington (1926) found that 0.4 ppm. of boron was stimulating to *Vicia faba*. Collings (1927) found that the dry weight of soy beans grown to maturity in nutrient solutions was increased by the addition of about 2.5 ppm. of boron and that this stimulation was greater when the boron was applied as boric acid than when it was applied as the borate. This increase in the dry weight was always accompanied, however, by symptoms of toxicity in the leaves, and no such stimulation was observed when the

plants were grown in soil or sand, nor when plants in the seedling stage were used as experimental material. Swanbeck (1927) found 2 ppm. of boron favorable for tobacco, and McMurtrey (1929) reported 0.5 ppm. as optimum for the same plant.

Several cases have been reported of plants which can apparently complete their development in the absence of boron, and which exhibit no stimulation effects when it is present. Agulhon (1910) was unable to find any favorable result when boron was added in the form of small traces of boric acid to cultures of yeast, *Aspergillus*, and Bulgarian ferment. This work, as well as that of Brenchley and Thornton (1925) on *Bacillus radicicola*, seems to indicate a lack of sensitivity on the part of lower plants toward the presence of boron in small quantities. Agulhon (1910) found that vetch was insensitive to any fluctuations in boron concentration below the toxic range, Warington (1923) reported that barley was able to attain optimum growth without the addition of any boron to the nutrient solution, and Brenchley (1927) stated that below the toxic range barley grew equally well in all concentrations down to 0.02 ppm. These results may indicate that some of the higher plants cannot be stimulated by boron, or they may mean that the optimum concentration for these plants is extremely low, and may be produced by the minute traces of the element carried as impurities in the nutrient salts employed.

The experiments described in this paper were undertaken with the purpose of studying various aspects of the physiological effects of boron on the wheat plant. The work was done in the laboratory of plant physiology of Columbia University under the supervision of Dr. S. F. Trelease, to whom the author is indebted for his interest and assistance.

METHODS

The experiments were of two types—the one, testing the effect of boron compounds in single salt solutions on the root growth of very young seedlings, and the other, upon the development of wheat plants grown in nutrient solutions during a period of nine weeks. In the seedling experiments the plants were exposed to the culture solutions for four days. Seeds of pure strain Marquis wheat were soaked in distilled water for three hours, drained, and rinsed thoroughly to remove dust and mould spores. They were then planted with forceps on moist filter paper in large glass culture dishes. Each seed was placed with the grooved side downward, and during this process obviously diseased or abnormal seeds were discarded. After about twenty-four hours, or an interval sufficient to allow the production of a root growth of six millimeters, uniform seedlings were selected and transferred to the culture solutions.

The solutions were prepared by dissolving a weighed amount of the required salt and diluting to a given concentration. The values for these solutions are stated throughout the paper as gram molecules per liter, gram atoms per liter, or as parts per million of solution. At first the water for these experiments was distilled in a Barnstead still, but later it was found necessary to redistill through quartz condensers in order to obtain uniformity of results.

The culture vessels (Trelease and Trelease, 1926) consisted of Pyrex glass beakers of two sizes, the smaller of 300 cc. and the larger of 600 cc. capacity. Paraffined bobbinet was fastened over the tops of the smaller beakers with paraffined linen thread. The smaller beakers were then inserted in the larger ones, and the solutions were poured into these pairs of beakers until both the inner and the outer were filled up to the level of the bobbinet.

The seedlings were then transferred from the germinating dishes with forceps and placed so that their roots extended down through the bobbinet into the culture solution. Twenty-five seedlings were grown in each beaker, and duplicate cultures were used for each concentration so that data for the growth of fifty seedlings were provided in each experiment. With each series one set of controls was grown in distilled water, and two sets in a standard, three-salt nutrient solution containing 0.02 m calcium nitrate, 0.02 m magnesium sulphate, and 0.02 m potassium acid phosphate.

The beakers were covered with watch glasses and transferred to a rotating table in a dark, thermostatic chamber (Trelease, 1925), where they were kept at a temperature of 19° C. for four days. At the end of this time the seedlings were removed, measurements of the central primary root were made, and the mean growth increment for the set was calculated.

Throughout the experiment care was taken not to introduce any impurities into the solutions. All beakers, germinating dishes and graduates were washed in hot, soapy water, rinsed several times in tap water, and finally dipped in hot, distilled water before use.

In the long-time experiment, the plants were grown for nine weeks in a standard nutrient solution to which varying concentrations of borax or boric acid were added. The standard solution contained 0.01 m potassium acid phosphate, 0.005 m magnesium sulphate, 0.005 m calcium nitrate, and 0.00001 m ferrous sulphate. The seeds used were Marquis variety (1930, Saskatchewan) and they were germinated as in the previous experiments. At the end of twenty-four hours the seedlings were transferred to enamelware pans. These pans were arranged on the same principle as the beakers in the seedling experiments. A smaller one, covered with bobbinet, was placed inside of a larger, and the two were filled with distilled water up to

the level of the bobbinet cover. The seedlings were grown for four days in these pans and were then transferred to the culture vessels. This use of enamel-ware pans is not recommended unless the surface of the enamel is entirely free from cracks or other imperfections. It was found in several cases where chipping of the enamel had occurred that the underlying metallic substances were dissolved by the distilled water and were highly toxic to the roots of the seedlings. In subsequent experiments Pyrex oven-ware pans have been employed.

The culture vessels consisted of glazed crocks of 7500 cc. capacity. These crocks were obtained from the General Ceramics Company and were composed of "chemical stone-ware." Each crock was covered with a cement lid perforated with five holes into which were fitted corks similarly perforated with five small holes. The lids and the corks were both well coated with paraffin. The crocks were filled with the solutions and the seedlings slipped through the perforations and secured with cotton so that the shoot extended above the surface of the lid while the roots were suspended in the solution underneath.

Thirteen different solutions were used—one to which no boron was added, six to which it was added in the form of boric acid, and six to which it was added in the form of borax. Two complete series were grown with duplicate solutions; but in one series the culture solutions were renewed every week, and in the other they were unrenewed. To the unrenewed solutions distilled water was added each week to replace the volume lost through evaporation and transpiration. Since the effect of the absence of boron was one of the points under consideration in this experiment, care was taken to use salts of high, tested purity, and the distilled water used was freshly prepared in a new, steam heated Barnstead still.

The crocks were mounted on three rotating tables in the greenhouse and exposed to prolonged illumination by means of one 1000 watt Mazda lamp suspended over each table and turned on from about 3:30 to 10:00 p. m. The temperature in the greenhouse was kept fairly uniform, seldom fluctuating above 25° C. or below 18° C. and for the most time remaining well within these limits. Atmometer readings were kept to measure the evaporation conditions prevailing during the experiment and to check the uniformity of these conditions for the three tables. These readings, obtained from Livingston spherical atmometers, indicated a mean evaporation rate of 19 cc. a day. As an additional precaution to insure environmental uniformity, the crocks were shifted from one table to another each week. At the end of nine weeks the plants were harvested and examined for general growth conditions. The tops of the individual plants and the roots of all the plants in each culture, collectively, were stored in separate

manila bags until they became air-dry. They were then dried in an oven at 100° C. for twenty-four hours and weighed.

RESULTS AND DISCUSSION

At first a number of experimental series were tried in which young seedlings were grown for four days in various boron solutions, and the root elongation was used as a criterion of general growth conditions. This method was found by Trelease and Trelease (1925) to be a simple method of estimating quantitatively the effects of certain solution conditions on plant growth. The general results obtained with this method showed a striking similarity to the data secured later by taking the dry weights of plants grown in nutrient solutions over a period of nine weeks.

Effects of boron on the growth of very young seedlings

The toxic effects of boron on wheat roots. A number of tests were made to determine the effect of various boron compounds, the ranges of toxic concentrations, and the stimulating concentrations, if present. At first borax was used as a source of boron (table 1). Later, experiments were tried with

TABLE 1

Growth of wheat roots in solutions containing varying concentrations of borax. Growth values represent the actual growth increment in each of two duplicate cultures and also their average growth expressed as a percentage of the growth in the standard three-salt solution. The values for the average growth in distilled water for the series represented in this table were 67, 69, and 71 per cent of the growth in the standard three-salt solutions.

GRAM MOLECULES OF BORAX PER LITER	GRAM ATOMS OF BORON PER LITER	GROWTH						
		1A mm.	1B mm.	Per cent	1A mm.	1B mm.	Per cent	Ave. Per cent
0.000001	0.000004	66	63	77	—	—	—	77
0.00001	0.00004	82	81	103	71	74	87	95
0.0001	0.0004	104	106	113	99	95	115	114
0.0002	0.0008	93	97	119	—	—	—	119
0.00045	0.0018	85	101	116	—	—	—	116
0.001	0.004	48	48	60	39	60	60	60
0.0025	0.01	20	20	25	—	—	—	25
0.004	0.016	9	10	13	—	—	—	13
0.0063	0.0252	6	2	5	—	—	—	5
0.01	0.04	2	1	3	—	—	—	3
0.1	0.4	0	0	0	—	—	—	0

boric acid (table 2) and potassium borate (table 3) in order to determine to what extent the effects observed in the borax series might be attributed to the presence of boron. The data for these three sets of experiments have been plotted in figure 1, in which growth is expressed in percentage of the root elongation occurring in the standard, three-salt solution, and the con-

centrations are based on a common scale—the number of gram atoms of boron per liter of solution. One gram atom of boron weighs 10.8 grams.

TABLE 2

Growth of wheat roots in solutions containing varying concentrations of boric acid. Growth values represent the actual growth increment in each of two duplicate cultures and also their average growth expressed as percentage of the growth in the three-salt control. The growth values obtained in distilled water for these experiments were 73, 95, 89, and 81 per cent of the growth in the three-salt solutions.

GRAM MOLECULES OF BORIC ACID OR GRAM ATOMS OF BORON PER LITER	GROWTH									
	1A mm.	1B mm.	Per cent	2A mm.	2B mm.	Per cent	3A mm.	3B mm.	Per cent	Ave. Per cent
0.00001	68	71	76[a]	65	75	90	—	—	—	90
0.0001	69	73	77[a]	77	73	97	60	61	90	94
0.0005	61	74	99	72	72	92[b]	—	—	—	96
0.001	72	74	78[a]	64	68	97	74	74	95[b]	96
0.00215	70	60	93	—	—	—	—	—	—	93
0.00463	52	47	71	—	—	—	—	—	—	71
0.005	44	35	59	—	—	—	—	—	—	59
0.01	31	31	34[a]	28	26	39	—	—	—	39
0.0215	11	11	16	—	—	—	—	—	—	16
0.04634	1	1	1	—	—	—	—	—	—	1
0.1	0	0	0	—	—	—	—	—	—	0

[a] Because of abnormally high values for the nutrient control in this series, it is believed that the percentages for these concentrations are too low. They have, therefore, been omitted in calculating the average.

[b] Values obtained by using double the number of experimental plants—i.e., four beakers with twenty-five seedlings in each.

TABLE 3

Growth of wheat roots in solutions containing varying concentrations of potassium borate. Growth values represent the actual growth increment in each of two duplicate cultures and also their average growth expressed as a percentage of the growth in the three-salt control. The average growth in distilled water in this series was 87 per cent of the growth in the three-salt solution.

GRAM MOLECULES OF POTASSIUM BORATE PER LITER	GRAM ATOMS OF BORON PER LITER	GROWTH		
		1A mm.	1B mm.	Per cent
0.00001	0.00004	68	65	87
0.0001	0.0004	87	89	114
0.0002	0.0008	96	98	126
0.00045	0.0018	90	95	121
0.001	0.004	60	64	80
0.0025	0.01	11	10	14
0.01	0.04	0	0	0

From the tables and the curves plotted in figure 1 it is evident that the three compounds have a decidedly toxic effect when present in concentra-

tions of more than 0.005 gram atom of boron per liter. When the curves are thus plotted on the basis of equivalent boron concentrations, the similarity of the toxic ranges of the three substances is striking. All three curves at the concentration of 0.002 gram atom of boron per liter drop sharply and follow distinctly similar courses. A reduction of approximately 40 per cent of growth was obtained in all three cases at a concentration

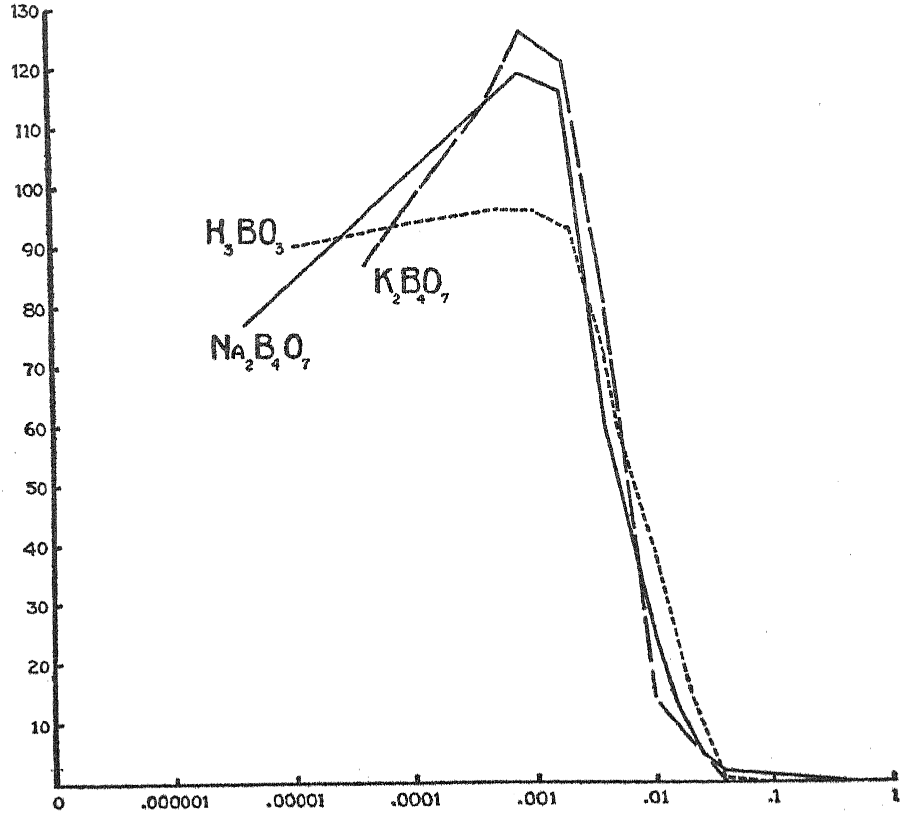


Fig. 1. Elongation of wheat roots in solutions of sodium borate, potassium borate, and boric acid. Ordinates represent percentages of elongation for the standard, three-salt control. Abscissas represent gram atoms of boron per liter.

containing 0.005 gram atom of boron per liter or 54 ppm. of boron; this concentration was supplied by 0.005 m boric acid, 0.00125 m borax, and 0.00125 m potassium borate. A concentration providing 0.04 gram atom of boron per liter (400 ppm.) completely inhibited growth in all three cases.

To further check the similarity in the toxic activity of these compounds, a series was tried using a constant concentration of boron (0.1744

grams or 0.016 gram atom of boron per liter) obtained by mixing borax and boric acid in varying proportions. The results of this experiment (table 4) show that there are relatively small differences in the toxic effects, although the pH values range from 6.4 to 8.8. Borax appears slightly more toxic than boric acid, an observation indicated also by the relative positions of the curves in figure 1. The increase in growth between pH 6.6 and 8.0 appears to be significant. This may indicate a slight conditioning effect of hydrogen-ion concentration upon the degree to which boron toxicity may manifest itself. Or, if the boron toxicity is assumed to be constant, it indicates that this range of hydrogen-ion concentrations is less toxic than are higher and lower hydrogen-ion concentrations.

TABLE 4

Growth of wheat roots in solutions containing 0.1744 grams of boron per liter obtained with mixtures of borax and boric acid in varying proportions. The value for the distilled water cultures was 83 per cent of the growth in the three-salt controls.

GRAM MOLECULES OF BORAX PER LITER	GRAM MOLECULES OF BORIC ACID PER LITER	GROWTH			pH VALUES
		1A mm.	1B mm.	Per cent	
0.00001	0.0160	11	11	15	6.4
0.00005	0.0158	14	15	21	6.6
0.0001	0.0156	15	15	21	7.0
0.0005	0.0140	17	18	25	7.7
0.001	0.0120	16	16	22	8.0
0.0025	0.0060	9	9	13	8.6
0.0035	0.0020	7	7	10	8.8

In studying the toxicity of boron, the question arose as to whether this was an effect such as one might expect in any single-salt solution, or whether it was of a different nature. Osterhout (1908) demonstrated that single-salt solutions were toxic, and that the toxicity of such solutions in most cases might be overcome by the addition of another salt. Later extensive work on antagonism has indicated that the toxicity of many cations may be overcome by the addition of some other cation, and that calcium is particularly effective in such antagonism (McCool, 1913; Osterhout, 1922). Agulhon (1910) reported that the concentrations of boric acid which he used were not so toxic in soil as in sand cultures; and he proposed, as one possible explanation, the fixation of boron in the soil in the form of insoluble borates of calcium. Brenchley and Warington (1926), on the other hand, found that enough boron could be obtained from the relatively insoluble borates of cobalt and calcium to depress the growth of *Vicia faba*.

This question suggested an experiment to test whether calcium is effective in antagonizing boron toxicity. At first an attempt was made to

add varying concentrations of calcium nitrate to a 0.01 m solution of borax; but it was found that, even when the calcium nitrate was diluted to a 0.000001 m concentration, precipitation occurred. Test experiments were then made to find a suitable working concentration of borax that would be toxic, and still not cause precipitation of the calcium. A 0.004 m solution of borax (0.016 gram atom of boron per liter) was finally chosen, and to this concentration were added varying amounts of calcium nitrate. The results of this experiment (table 5) seem to indicate an absence of any significant degree of antagonism existing between calcium and boron, and an additive toxic effect with the higher concentrations of calcium. Similar results were obtained (table 5) when calcium nitrate was added, in varying amounts, to a 0.0196 m solution of boric acid (0.0196 gram atom of boron per liter). It is apparent from these data that borax and boric acid are definitely toxic in concentrations that are too low to cause precipitation of calcium, and that there is no antagonism between calcium and either of these substances.

TABLE 5

Growth of wheat roots in a toxic, 0.004 m concentration of borax to which varying concentrations of calcium nitrate have been added.

GRAM MOLECULES OF CALCIUM NITRATE PER LITER	GROWTH					
	1A mm.	1B mm.	Per cent	2A mm.	2B mm.	Per cent
0.000001	11	10	17	7	7	10
0.00001	11	11	17	10	10	14
0.0001	10	12	17	9	9	12
0.001	8	6	11	7	7	10
0.01	3	3	5	4	3	6
0.1	0	0	0	1	1	1

Growth of wheat roots in a toxic, 0.0196 m concentration of boric acid to which varying concentrations of calcium nitrate have been added.

GRAM MOLECULES OF CALCIUM NITRATE PER LITER	GROWTH		
	1A mm.	1B mm.	Per cent
0.000001	7	9	10
0.00001	7	9	10
0.0001	9	10	12
0.001	9	13	13
0.01	11	13	14
0.1	5	6	7

A similar experiment on possible antagonistic effects was suggested by

the report by Haas (1929) that iron, added to a culture solution containing 7.5 ppm. of boron, materially decreased the toxic action of boron on citrus seedlings. Culture solutions were prepared which contained 0.0025 m potassium borate (0.01 gram atom of boron per liter) with the addition of varying concentrations of ferrous sulphate. When concentrations of more than 0.001 m ferrous sulphate were added to the boron solution, a dark green precipitate was formed, and in the 0.001 m solution an orange precipitate was produced. From table 6 it can be seen that the only case in which there is an increase of growth over that of the culture supplied with boron alone is in the 0.001 m solution of ferrous sulphate—the highest concentration used and the only one in which precipitation occurred. In this instance the decrease in toxicity of the solution is apparently due to the removal of a certain proportion of the borate ions by precipitation. Mellor

TABLE 6

Growth of wheat roots in a 0.0025 m solution of potassium borate to which were added varying concentrations of ferrous sulphate. The growth in distilled water was 68 per cent of the growth in the three-salt control.

GRAM MOLECULES OF FERROUS SULPHATE PER LITER	GROWTH		
	1A mm.	1B mm.	Per cent
0.000000	20	17	21
0.000001	20	17	21
0.00001	13	13	15
0.0001	16	19	20[a]
0.001	32	26	34[a]

[a] Concentrations of ferrous sulphate higher than 0.001 m caused the formation of a blue-green precipitate and so were not used. In the 0.001 m concentration an orange precipitate formed and the 0.0001 m solution was tinged with yellow.

(1924) has recorded the formation of ferrous borate in this way by double decomposition with borax and a ferrous salt solution. There is no evidence of any true antagonism existing between iron and boron.

From these experiments it would seem that the toxicity of boric acid and the borates is a special effect characteristic of the boron compounds. It depends directly upon the concentration of boron, irrespective of any balance existing between boron and other substances in the nutrient medium. This casts an interesting light on the conception of boron toxicity.

It is to be expected that boron in single-salt solutions should be toxic, but the curious fact is that it is less toxic under such conditions than are most of the so-called "nutrient" elements. Figures collected from papers published by Trelease and Trelease (1926), Barton and Trelease (1927), and Eisenmenger (1928) indicate that, in single-salt solutions, manganese

chloride, magnesium nitrate, calcium nitrate, and potassium acid phosphate are more toxic than any of the boron compounds used in the experiments described above. A 0.006 m solution of magnesium nitrate permitted 8 per cent as much growth as the control solution, a 0.005 m solution of manganese chloride permitted 2 per cent, and a 0.006 m solution of calcium nitrate permitted 31 per cent, whereas an equivalent concentration of boron in any of its various compounds permits 60 per cent as much growth as the control. Trelease and Trelease (1926) obtained a growth of 77 per cent in a 0.006 m solution of potassium nitrate, while Eisenmenger (1928) found a growth of only 37 per cent of the control in the same concentration of potassium acid phosphate, indicating that the toxicity of these metallic salts in simple solutions is conditioned by the anion constituent of the salt. A comparison of boron with these other nutrient elements may be safely made on the basis of these figures because the methods employed in the boron experiments were the same as those used by these previous workers, and the experimental material was wheat in each case.

All of these authors found that the toxicity of these salts is greatly reduced when other salts are added, and have thus demonstrated antagonism between various pairs of ions. No such relationships are observable in the results obtained with boron. The toxicity remains practically constant, irrespective of the form of the boron compound; no antagonism exists between calcium or iron and boron, and as will be shown later in the long-time experiments, the toxicity in a balanced nutrient solution is practically the same as that in a single-salt solution.

Optimum boron concentrations for root growth of seedlings. From tables 1, 2, and 3, and figure 1, it is apparent that there is an optimum range of boron concentrations below which there is a gradual decrease in growth with decreasing concentration, and above which any increase in concentration causes a decided drop in the growth rate as toxicity becomes an important factor. This range includes concentrations of boron between 0.0002 and 0.002 gram atom of boron per liter or between 2 and 20 ppm., and is the same for all three boron compounds.

The amount of growth produced in this optimum range of boron concentrations, however, is decidedly different with the boric acid and the two alkaline borates. The growth in the optimum boric acid concentrations, although it exceeds that in distilled water, does not surpass the growth in the three-salt, standard solution. In the optimum concentrations of the alkaline borates, on the other hand, the growth values indicate marked stimulation. A study of the hydrogen-ion concentration in these optimum ranges indicates that the best growth in the alkaline borates occurs at about pH 8.5, whereas the optimum growth in the boric acid cultures occurs at pH 6.8.

A question here presented itself as to whether the borate ion is stimulating in itself, under the conditions of these experiments, or whether the increase in growth, found here only in the cultures containing the alkaline borates, might not be due simply to the alkalinity of the medium. In order

TABLE 7

Growth of wheat roots in solutions of sodium carbonate, sodium bicarbonate, and sodium chloride. The distilled water values for the three series were respectively 88, 87, and 90 per cent of the growth in the three-salt control.

GRAM MOLECULES OF SODIUM CARBONATE PER LITER	GROWTH			pH VALUES
	1A mm.	1B mm.	Per cent	
0.000005	61	70	88	7.0
0.00005	76	79	104	7.2
0.00007	81	80	108	7.6
0.00014	86	83	113	8.8
0.00019	90	84	116	8.8
0.0005	94	94	125	8.8
0.005	1	1	1	8.8

GRAM MOLECULES OF SODIUM BICARBONATE PER LITER	GROWTH			pH VALUES
	1A mm.	1B mm.	Per cent	
0.0001	70	68	108	6.6
0.0005	85	89	114	7.1
0.001	83	87	113	7.6
0.002	65	67	103	7.8
0.005	61	59	94	8.2
0.01	30	20	39	8.4
0.1	0	0	0	8.4

GRAM MOLECULES OF SODIUM CHLORIDE PER LITER	GROWTH			pH VALUES
	1A mm.	1B mm.	Per cent	
0.00001	75	78	96	6.6
0.0001	75	80	97	6.6
0.001	73	80	96	6.6
0.005	70	70	88	6.6
0.01	57	57	71	6.6
0.05	2	3	4	6.6
0.1	0	0	0	6.6

to test the effect of other alkaline salts on the growth of wheat, two experiments were made with solutions of sodium carbonate and sodium bicarbonate, and a third with sodium chloride, for purposes of comparison. The results are shown in table 7. In figure 2 the growth values for these

three sets of cultures are plotted with the values for sodium borate, using, as a common basis, the sodium concentration of the four compounds. The graph and table bring out very clearly the differences in the stimulating power of these four sodium salts. With sodium borate there is marked stimulation at pH 8.6; with sodium carbonate, at pH 8.8; with sodium bicarbonate, a slightly lower stimulation between pH 7.1 and 7.8. In the case

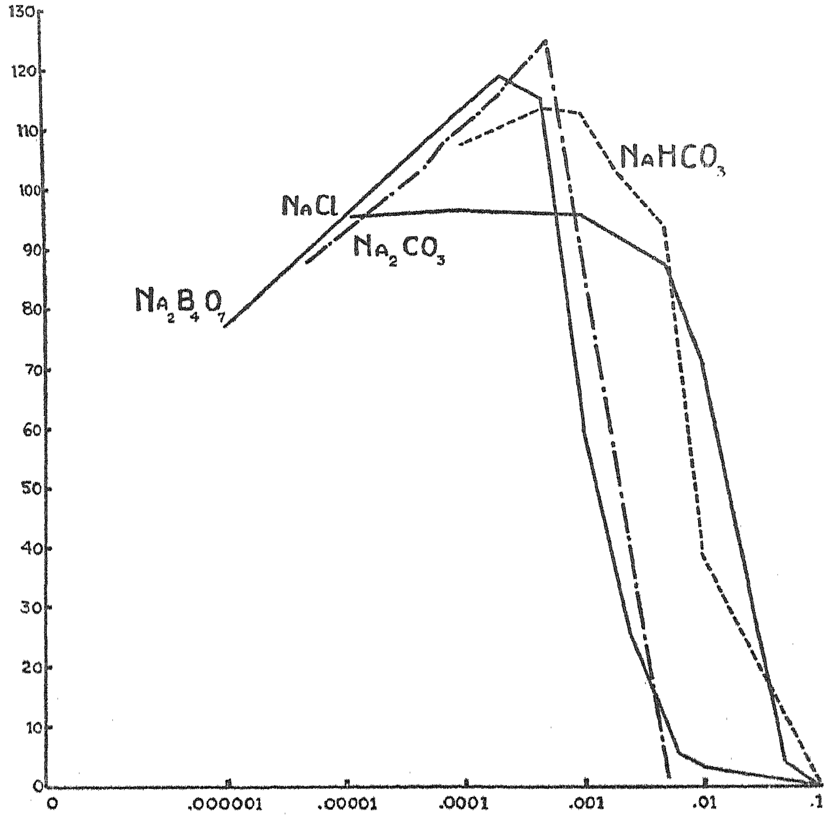


Fig. 2. Elongation of wheat roots in solutions of sodium borate, sodium carbonate, sodium bicarbonate, and sodium chloride. Ordinates represent percentages of elongation for the standard, three-salt control. Abscissas represent gram atoms of sodium per liter.

of the neutral sodium chloride, where the pH value for all the concentrations is 6.6, there is no evidence of stimulation apparent. This difference between the effects of the alkaline and neutral sodium salts on the growth of wheat roots is suggestive of the difference between the results obtained with the alkaline borates and those obtained with boric acid—solutions of the latter having about the same pH value as solutions of sodium chloride.

Effects of boron on wheat plants grown for nine weeks in nutrient solutions

The difficulty in the interpretation of the stimulation in the experiments dealing with the earliest phases of seedling development lies in the fact that the plants are still dependent on inorganic nutrients as well as organic food stored in the seed. Inasmuch as a three-salt solution in itself might be considered stimulating under these circumstances, it is difficult to know whether the distilled water cultures or the three-salt solutions should be considered as the controls on which to base stimulation results. For this reason plans were made for growing wheat plants in boron cultures over a longer period of time in order to determine possible stimulating effects of the boron compounds with a greater degree of precision.

In this experiment wheat plants were grown in a standard nutrient solution, to which boron, in the form either of borax or boric acid, was added.

TABLE 8

Dry weights of the tops of wheat plants grown for nine weeks in renewed and unrenewed solutions containing varying quantities of boron, supplied either as boric acid or borax.[a]

NO.	GRAM ATOMS OF BORON PER LITER	PPM. OF BORON	pH_1	RENEWED SOLUTIONS OF BORIC ACID		UNRENEWED SOLUTIONS OF BORIC ACID	
				Weight mgm.	pH_2	Weight mgm.	pH_2
1	None	0.0	4.6	282± 8	5.2	224±5	5.8
2	0.000010	0.1	4.6	240± 9	4.8	210±5	5.8
3	0.000032	0.3	4.6	288±11	4.8	216±6	5.8
4	0.000100	1.0	4.6	212± 6	4.8	198±6	5.6
5	0.000316	3.4	4.6	206± 7	4.8	219±7	5.8
6	0.001000	10.8	4.6	205± 5	4.8	215±6	5.7
7	0.003160	34.0	4.6	150± 4	4.8	196±7	5.5
NO.	GRAM ATOMS OF BORON PER LITER	PPM. OF BORON	pH_1	RENEWED SOLUTIONS OF BORAX		UNRENEWED SOLUTIONS OF BORAX	
				Weight mgm.	pH_2	Weight mgm.	pH_2
8	0.000010	0.1	4.6	302± 6	5.2	197±5	5.8
9	0.000032	0.3	4.6	354± 9	5.2	198±5	5.8
10	0.000100	1.0	4.8	437±12	5.2	185±4	5.8
11	0.000316	3.4	4.9	473±15	5.3	173±3	5.8
12	0.001000	10.8	5.4	508±18	5.5	151±5	5.8
13	0.003160	34.0	5.9	407± 9	5.7	82±3	5.8

[a] Weight values represent an average obtained from the weights of twenty-five plants; they are followed by their probable errors.

The value pH_1 represents the initial pH of the solution.

The value pH_2 in the case of the renewed solutions refers to the pH at the end of one week and in the unrenewed solutions to the value at the end of nine weeks.

The boron concentrations were selected to include the optimum range previously demonstrated in the seedling experiments. One set of plants was grown in a boron-deficient medium in order to study the effect of a lack of boron on wheat, six cultures were supplied with boric acid, and six with borax. The boric acid and the borax solutions were made up so that corresponding cultures contained equal concentrations of boron. This series furnished experimental material for studying the effect of boron deficiency,

TABLE 9

Dry weights of the roots of wheat plants grown for nine weeks in renewed and unrenewed nutrient solutions containing varying quantities of boron supplied either as boric acid or borax.[a]

NO.	GRAM ATOMS OF BORON PER LITER	PPM. OF BORON	pH_1	RENEWED SOLUTIONS OF BORIC ACID		UNRENEWED SOLUTIONS OF BORIC ACID	
				Weight mgm.	pH_2	Weight mgm.	pH_2
1	None	0.0	4.6	21	5.2	25	5.8
2	0.000010	0.1	4.6	19	4.8	29	5.8
3	0.000032	0.3	4.6	28	4.8	26	5.8
4	0.000100	1.0	4.6	19	4.8	23	5.6
5	0.000316	3.4	4.6	16	4.8	25	5.8
6	0.001000	10.8	4.6	18	4.8	22	5.7
7	0.003160	34.0	4.6	13	4.8	15	5.5

NO.	GRAM ATOMS OF BORON PER LITER	PPM. OF BORON	pH_1	RENEWED SOLUTIONS OF BORAX		UNRENEWED SOLUTIONS OF BORAX	
				Weight mgm.	pH_2	Weight mgm.	pH_2
8	0.000010	0.1	4.6	32	5.2	24	5.8
9	0.000032	0.3	4.6	34	5.2	30	5.8
10	0.000100	1.0	4.8	46	5.2	35	5.8
11	0.000316	3.4	4.9	59	5.3	42	5.8
12	0.001000	10.8	5.4	50	5.5	38	5.8
13	0.003160	34.0	5.9	36	5.7	8	5.8

[a] The values represent one twenty-fifth of the total weight of the roots of twenty-five plants. The value pH_1 refers to the initial pH of the solution.

The value pH_2 refers to the pH at the end of one week in the case of the renewed solutions, and nine weeks in the case of the unrenewed.

and the comparative stimulation effects of boric acid and borax. It also allowed a study to be made of the concentrations at which boric acid and borax began to be definitely toxic. By duplication of cultures, an additional series was prepared for the purpose of studying the effects of boron concentrations in unrenewed solutions as compared with the effects of the same concentrations in the primary series in which the solutions were renewed weekly, providing a supply of 7500 cc. of nutrient medium for 25 plants

every seven days. This experiment furnishes growth data for 650 plants grown in twenty-six different nutrient environments. The dry weights obtained from this series are listed in tables 8 and 9, and plotted in figures 3 and 4. The photographs of plates 1 and 2 show the condition of the plants one week before the termination of the experiment, and the final appearance of the plants is described in table 10.

TABLE 10

Condition of plants grown in various boron solutions, with respect to flower formation and tillering at the time of harvesting.[a]

BORIC ACID CULTURES

PPM. OF BORON	RENEWED SOLUTIONS			UNRENEWED SOLUTIONS		
	Flowers	Buds	Tillers	Flowers	Buds	Tillers
0.0	1	12	33	0	12	0
0.1	0	8	22	0	15	0
0.3	1	21	39	0	6	0
1.0	0	15	19	0	1	0
3.4	0	15	21	0	5	0
10.8	0	18	17	0	5	0
34.0	0	5	5	0	2	7

BORAX CULTURES

PPM. OF BORON	RENEWED SOLUTIONS			UNRENEWED SOLUTIONS		
	Flowers	Buds	Tillers	Flowers	Buds	Tillers
0.0	1	12	33	0	12	0
0.1	1	20	32	0	0	0
0.3	1	23	40	0	5	0
1.0	9	16	37	0	0	0
3.4	10	14	34	0	0	0
10.8	14	10	23	0	0	0
34.0	0	19	11	0	0	1

[a] The term "flowers" in the above table refers to spikes completely emerged from the sheath, and the term "buds," to spikes formed and swollen, but still enclosed within the sheath.

Comparison of growth in renewed and unrenewed boron cultures. This study of the effect of renewal of solutions on the manifestation of boron effects is of particular significance. In the literature on boron, with the exception of the work by Warington (1923) and Collings (1927), no mention is made of the periodic and complete renewal of culture media. Sommer and Lipman (1926) and Johnston and Dore (1929) merely mention the renewal of the iron supply. McMurtrey (1929), in his work on the necessity of boron for tobacco, states that he did not renew his solutions "because frequent renewals tend to delay the manifestation of boron-deficiency symptoms."

The results of the experiment with renewed and unrenewed solutions bring out very clearly the discrepancies between data obtained by these two methods and the great desirability of renewing solutions in any attempt to discover the reactions of plants to known sets of solution conditions.

As early as the end of the first month there were marked differences in the condition of the plants in the two series, consisting chiefly of the rather pronounced chlorosis of the plants in the unrenewed series. This chlorosis was particularly advanced in the plants in those cultures supplied with un-

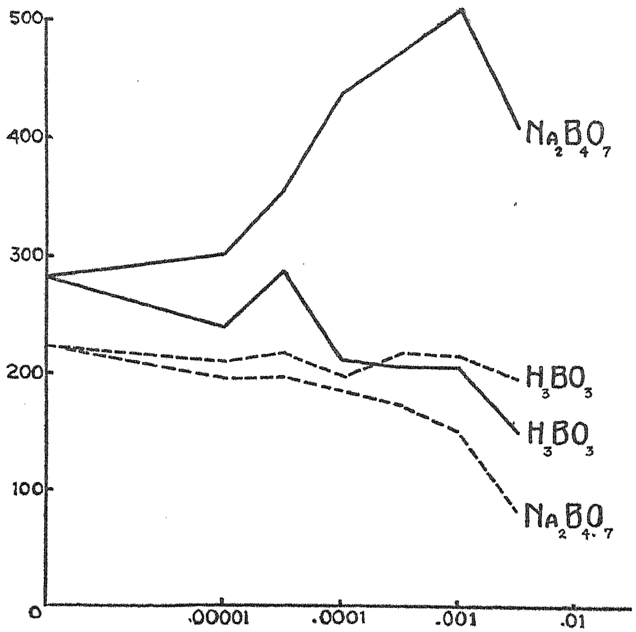


Fig. 3. Growth of tops of wheat plants grown in solutions containing borax and boric acid. Ordinates represent dry weights in milligrams. Abscissas represent gram atoms of boron per liter. Solid lines indicate renewed series and broken lines unrenewed series.

renewed solutions containing high concentrations of borax, and the difference between these cultures and their duplicates in the renewed series was particularly marked. It is possible that the chlorosis occurring in the unrenewed solutions was due in some part to iron deficiency, and that the greater depression of growth and increased chlorosis occurring in the high-borax cultures were caused by the further decrease in the availability of the iron due to reduced acidity. However, it is just as possible that these plants were equally affected by the lack of other nutrients, particularly in the highest borax concentration, where a visible, crystalline precipitate

lining the jar and encrusting the roots indicated that some nutrient material had been made unavailable to the plants. Premature tillering was observed at the end of the sixth week in both of the boron-deficient cultures, none occurring in any of the boron cultures until some time later. Even in this respect, however, a difference was observable between the renewed and unrenewed cultures, for in the unrenewed set every plant exhibited early tillering, whereas such tillers were present on only about one-half of the plants in the corresponding renewed solution. Moreover, in the case of the unrenewed set, these premature tillers died shortly after their formation, while those in the renewed culture grew normally.

Similarly an examination of the two sets of curves in figures 3 and 4 reveals the incompatibility of data obtained by these two methods. In the

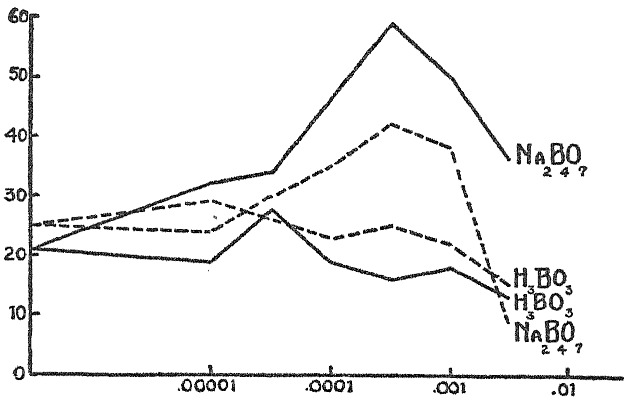


Fig. 4. Growth of roots of wheat plants grown in solutions containing borax and boric acid. Ordinates represent dry weights in milligrams. Abscissas represent gram atoms of boron per liter. Solid lines indicate renewed series and broken lines unrenewed series.

top growth, for instance, the curves indicate that borax produces greater dry weights than boric acid in the renewed cultures, whereas the reverse is true in the unrenewed solutions. This may be due to the fact that iron and other nutrients are less available in the borax cultures because of their lower acidity. Another striking difference is seen in the fact that those borax cultures which are most stimulating in the renewed series (3.4–34 ppm. of boron) exhibit the greatest toxicity in the unrenewed series.

The plants grown in the highest concentration of boric acid are also distinctly different in the two series. In both series, renewed and unrenewed, the dry weights of the plants indicate a decrease in growth as the margin of toxicity is approached. But in the renewed series this decrease in weight of the plants in the highest concentration of boric acid is shown

by the photographs of plate 1 to be accompanied by visible chlorosis and depression in growth, whereas in the unrenewed solutions the corresponding culture looks the best of the boric acid series. A similar discrepancy between the fresh weight or appearance of the plant and the dry weight has been described by Agulhon (1910) as characteristic of plants supplied with boric acid in amounts exceeding the optimum, and attributed to "overmineralization." The photographs of the series (plates 1 and 2) emphasize the difference in the results obtained by renewed and unrenewed solutions, and the description of the condition of the plants when harvested (table 10) yields further confirmation from the aspects of vegetative development and maturity. In no case had a flower spike completely formed and emerged from the sheath in any of the unrenewed solutions. In the renewed solutions there was one case in the boron-deficient control, one case in the boric acid cultures and thirty-six cases in the borax solutions. If spikes still enclosed in the surrounding sheath be included in the estimation of flowering, the unrenewed cultures showed fifty-one cases compared with two hundred and thirty-three cases in the renewed series. The total number of normal tillers in the unrenewed series was eight, compared with three hundred and thirty-three in the renewed series.

Growth in the boron-deficient controls. In these control cultures great care was taken not to introduce boron into the solutions through any chance contamination. The water used was always freshly distilled before the cultures were made up, and the salts used were of the highest grade obtainable commercially. Johnston (1928) discussed the problem of the introduction of boron into nutrient solutions from glazed earthen-ware jars and Pyrex glassware. New glazed jars afforded enough boron to supply the needs of tomatoes, but after the jars had been used several times, the amount of boron that was leached out by the solution was insufficient to prevent the appearance of boron-deficiency symptoms. The jars used in the present experiment were well seasoned, having been previously used in culture experiments. There is, of course, the possibility of contamination through the use of Pyrex bottles in which the stock salt solutions were stored; but Sommer (1927) states that Pyrex, although a boro-silicate, does not yield sufficient boron for the normal growth of at least some plants.

The plants grown in the boron-deficient solutions exhibited none of the serious symptoms described in the literature by Sommer and Lipman (1926), Swanbeck (1927), McMurtrey (1929), Johnston and Dore (1929), and Johnston and Fisher (1930). One significant observation was that of premature tillering in the plants of the two boron-deficient cultures, and no others. Abnormal branching has been described as a boron-deficiency symptom by Sommer (1927), McMurtrey (1929), and Johnston and Dore

(1929), and is believed to be a response to a disturbance in the apical dominance of the plant due to typical degeneration of the apical meristem. In the renewed series the dry weights of roots and tops are lower in the boron-deficient control than in any of the borax cultures. On the other hand, they exceed the dry weights obtained in all the boric acid cultures with the exception of the solution containing 0.3 ppm. of boron. Similar relationships with regard to the formation of flowers are brought out by table 10. In the renewed series, about one-half of the plants in the boron-deficient solution are shown to have formed spikes. This proportion is exceeded by the cultures in the optimum range of boric acid concentrations (0.3–10.8 ppm.); but curiously enough this proportion is greater than that found for the first boric acid concentration—0.1 ppm. of boron as boric acid. The proportion of flowering in the boron-deficient culture is exceeded by all of the borax cultures; thus borax had as marked an effect on flower production as on dry yields.

It is apparent from the data of this experiment that the wheat plants were capable of developing for at least nine weeks, up to the flowering stage, in solutions to which no boron was added. If it is assumed, as seems justified from the work of Sommer and Lipman (1926) on a similar grain, barley, that minute quantities of boron are indispensable for the growth of wheat, it is evident that these traces of boron must have been present as impurities in the salts or that they were provided by solution of the culture vessels. The fact that the amounts of boron required by cereal grains is exceedingly small in comparison with those required by the Leguminosae is indicated by Warington (1923), Brenchley and Warington (1927), and Brenchley (1927), who found that wheat, barley, and rye came to full maturity in solutions supposedly free of boron. At least, these solutions did not contain enough boron to allow the full development of broad beans, scarlet runner, alfalfa, and crimson, white, and lesser clover.

Growth in boric acid cultures. Since this long-time experiment was undertaken with the primary purpose in view of determining whether there are differences in the effects of boric acid and borax on the growth of wheat plants, it is of interest to compare the results obtained with these two compounds, using the renewed solutions as a basis of study. An examination of figure 3 and table 8 indicates that when boric acid was added to the culture solutions here employed, it induced no significant stimulation of top growth, as indicated by dry weights. In one concentration (0.3 ppm. of boron), the top weights are very slightly higher than those of the control plants grown in the boron-deficient solution, but this difference does not exceed the range of possible error and so may not be significant. In every other boric acid concentration tested, the dry weights of the tops are lower

than those in the control culture. This failure to secure definite indications of stimulation above the control with boric acid solutions is interesting, in view of the fact that the control, according to the results of Sommer and Lipman (1926) with barley, should be considered subnormal because it is deprived of an element essential to growth. The superiority of the growth in the 0.3 ppm. solution is further suggested by the appearance of the plants, as shown in the photographs of plate 1 and by the figures and curves for the dry weights of roots (table 9 and figure 4). The figures for the dry weights of the roots are somewhat unsatisfactory, since the entire root mass of twenty-five plants was weighed as a single unit and the range of experimental error is unknown, and also because an error was introduced in the higher concentrations by the fact that crystals had precipitated upon the surface of the roots and could not be completely removed. However, the figures probably do suffice to show the general trend of growth.

In this experiment, as in those conducted with very young seedlings, there is considerable doubt as to whether evidence was obtained of a stimulating action of boric acid, under the conditions of these tests. Perhaps the one sign of any significant stimulation is found in table 10, which shows, in the case of the 0.3 ppm. solution alone, an increase in the number of flowers formed and a slight increase in the number of tillers. The curve for the boric acid cultures, with the one exception of the point representing the 0.3 ppm. yield, shows a gradual downward trend from the control, as the concentration of boric acid is increased. The highest boric acid concentration (34 ppm. of boron) exerted a definitely toxic effect, as shown by the drops in the curves for root and top growth, and by the photograph of this culture (number 7) in plate 1. This result is in keeping with data obtained in the young seedling experiments which indicate that a solution containing 34 ppm. of boron is within the toxic range.

Growth in borax cultures. The curves for the growth in the renewed solutions of borax and the photographs of the plants grown in these cultures (plate 2) leave little doubt as to the stimulation resulting from the addition of borax in concentrations varying from 1 to 34 parts per million of boron to the basic solution employed in this experiment. A study of the curves in figures 3 and 4 shows that there is an increase in dry weight with increasing concentrations of borax up to an optimum concentration supplying 10.8 ppm. of boron. In this solution the top growth, as evidenced by dry weight, is almost twice as great as that in the control, and the root growth almost three times as great. Above this point an increase in the concentration of boron is accompanied by a decrease in dry yield, as the optimum is passed and the range of toxicity is entered. The highest borax concentration used, providing 34 ppm. of boron, although it is definitely

above the optimum for growth, nevertheless permits the development of healthy, green tops, as well as greater dry weight and a higher proportion of flowering than the control. In the renewed borax cultures (table 10) it was found that there is an increase in the number of completely opened spikes which is correlated with increasing borax concentration until the 10.8 ppm. concentration is passed. This luxuriant growth in the high borax cultures is surprising in that the concentrations used exceed those commonly thought of as optimal or even safe.

Even more surprising, perhaps, than the relatively low toxicity of borax is the difference between the results obtained in the borax cultures and those obtained in the corresponding boric acid cultures containing equivalent gram-atomic concentrations of boron. This difference closely parallels the results based on the root elongation of very young seedlings studied in the previous experiments, but it is surprising nevertheless. In the first place, the optimum concentrations of boric acid and borax are entirely different. In the boric acid curve, with the exception of the point for the 0.3 ppm. concentration, there is a general downward trend. In the borax curve, there is a pronounced rise toward the optimum concentration of 10.8 ppm., with depression in the higher concentration. In none of the renewed boric acid cultures, with the exception of the apparently optimum concentration, does the growth equal or exceed that of the control, whereas in the borax cultures every tested concentration, including the one which supplies only 0.1 ppm. of boron, produces better growth than that in the control solution. Agulhon (1910) reported that boric acid solutions containing 2.5 to 10 ppm. of boron were stimulating to wheat grown in sterile cultures, but that higher concentrations decreased growth, the concentration of 20 ppm. being definitely toxic. These figures do not agree with the data for boric acid found in the present study. Stimulation here occurs at 0.3 ppm., if at all, and all concentrations above this result in a depression of growth. Agulhon's figures do, however, bear some resemblance to the results here obtained with the borax cultures.

The results of the long-time experiment bear out the preliminary findings in the seedling experiments, indicating that there is a marked difference between the stimulating effects of the alkaline and acid borates on the growth of wheat. Unlike boron toxicity, which for a given plant is a fairly constant function of the boron concentration and is not greatly altered by the nutrient balance or the reaction of the solution, the stimulation effects observed in these experiments with wheat seem to be conditioned by the hydrogen-ion concentration of the medium. It seems reasonable to discard the possibility that the sodium ion in itself is responsible for the stimulation found in the borax cultures, because in the experiments with

young seedlings it was found that the neutral sodium chloride failed to produce the stimulation which was produced by the alkaline sodium salts, the borate, carbonate, and bicarbonate. Duggar (1920) reported that nutrient solutions with higher pH values than those commonly obtained with high concentrations of the acid phosphates were favorable to wheat plants, particularly when grown under conditions inducing high transpiration rates. An examination of the pH values for the solutions (table 8) used in the long-time experiment shows that the boric acid and boron-deficient solutions all had an initial pH value of 4.6, and that the borax solutions ranged from 4.6 to 5.9. By the time for solution renewal at the end of the first week, the boron-deficient solutions had shifted to 5.2, all of the boric acid cultures to 4.8, and the borax solutions to values varying from 5.2 to 5.7. These differences in pH values are apparently correlated with the superiority in growth of the borax and boron-deficient cultures over the majority of the boric acid cultures.

Two possibilities are suggested by these results. The differences between the results in the boric acid and borax cultures may indicate that the hydrogen-ion concentration serves as a sort of limiting factor for boron stimulation in wheat, or that the alkalinity of the borax in itself may be the causal factor in this stimulation. If the latter supposition is true, it appears that a frequently renewed culture solution having a pH value of 5.5 is far superior for the growth of wheat to a similar solution having a pH value of 4.8.

TABLE 11

The growth of wheat roots in nutrient solutions, the pH values of which were varied by using different proportions of monobasic and dibasic potassium phosphate.[a]

KH_2PO_4, cc. in 1100 cc.	K_2HPO_4, cc. in 1100 cc.	pH	Growth		
			1A mm.	1B mm.	Ave. mm.
44.0	0.0	4.4	90	84	87
41.8	2.2	5.0	95	97	96
39.6	4.4	5.4	95	95	95
35.2	8.8	5.8	89	92	91
31.8	13.2	6.0[b]	85	83	84

[a] Each solution contained 0.02 m calcium nitrate, 0.02 m magnesium sulphate, and 0.02 m potassium phosphate.

The distilled water values were 77 and 82 mm., the average being 80 mm.

[b] Slight precipitation of calcium or magnesium occurred in this solution.

Some indication that the remarkable difference between the boric acid and borax series is primarily due to the difference in the hydrogen-ion concentration may be obtained from a subsequent test that was made with

very young wheat seedlings. Nutrient solutions were used which contained 0.02 m calcium nitrate and 0.02 m magnesium sulphate, and varying proportions of 0.02 m acid potassium phosphate and 0.02 m dibasic potassium phosphate. This series afforded a pH range from 4.4 to 6.0, and the results (table 11) indicate a slight increase in growth in the cultures with pH values between 5.0 and 5.8. The results for this experiment add further weight to the supposition that lower hydrogen-ion concentration in itself may be the important factor. Further work would be necessary, however, using solutions in which the boron factor is kept constant, and at a minimum, and the hydrogen-ion concentration varied, in order to prove definitely that the alkalinity of these borax solutions is the sole factor responsible for the remarkable stimulating effect they exert on wheat.

SUMMARY

The following conclusions are derived from observations made on the root growth of wheat seedlings supplied with boron solutions during a period of four days following germination, and also on the development of wheat plants in nutrient solutions over a period of nine weeks:

The degree of the toxicity of boron compounds depended on the concentration of the boron in the solution. Potassium borate, sodium borate, and boric acid exhibited similar toxicity when the boron concentrations which they afforded were equivalent.

A concentration of approximately 50 ppm. of boron caused a retardation of 40 per cent in the growth of wheat, and a concentration of 100 ppm. inhibited growth almost completely.

The toxicity of boron was the same whether the element was supplied to the plants in the form of a single-salt solution or as a component in a balanced nutrient medium.

No antagonism was evident between boron and either calcium or iron.

An optimum range of concentrations of sodium borate and potassium borate lay between 3 and 20 ppm. of boron. These alkaline borates were distinctly stimulating to the root growth of young seedlings, and to the development of plants grown for nine weeks (to the flowering stage). The optimum concentration of each salt corresponded to about 10.8 ppm. of boron.

Solutions of boric acid, on the other hand, did not stimulate the growth of the roots of very young seedlings. A slight stimulating effect, as evidenced by dry weights and flower development of the mature plants, was noted only in the boric acid solution containing 0.3 ppm. of boron.

From the results obtained with very young wheat seedlings grown in solutions of alkaline and neutral sodium salts, and in nutrient solutions in

which the hydrogen-ion concentration was varied by altering the proportions of monobasic and dibasic potassium phosphate, it is apparent that alkalinity was an important factor in the stimulation of these seedlings. The results of the experiment of long duration indicate a similar superiority of lowered hydrogen-ion concentration for wheat plants grown to the flowering stage. The difference between the growth in optimum concentrations of the alkaline borates and equivalent concentrations of boric acid may be due either to the fact that the low hydrogen-ion concentrations of the potassium and sodium borates is the direct cause of stimulation, or that the hydrogen-ion concentration of the culture medium serves as a limiting factor determining the extent to which boron stimulation may manifest itself. Most of the evidence secured in this study seems to favor the former alternative.

The results with initially identical renewed and unrenewed solutions were so incompatible as to render questionable many of the data on boron published from results obtained with unrenewed solutions.

DEPARTMENT OF BOTANY
COLUMBIA UNIVERSITY
NEW YORK CITY

Literature cited

Agulhon, Henri. 1910. Recherches sur la présence et la rôle du bore chez les végétaux. Thèse—Université de Paris. Laval: L. Barnéoud et Cie.

Barton, L. V., and S. F. Trelease. 1927. Stimulation, toxicity, and antagonism of calcium nitrate and magnesium chloride as indicated by the growth of wheat roots. Bull. Torrey Bot. Club **54:** 559–577.

Blair, A. W., and B. E. Brown. 1921. The influence of fertilizers containing borax on the yield of potatoes and corn. Soil Sci. **11:** 369–376.

Brenchley, W. E. 1927. Inorganic plant poisons and stimulants. 134 p. Cambridge.

———, **and H. G. Thornton.** 1925. The relation between the development, structure, and functioning of the nodules in *Vicia faba*, as influenced by the presence or absence of boron in the nutrient medium. Proc. Roy. Soc. London B, **98:** 373–398.

———, **and K. Warington.** 1926. The rôle of boron in the growth of plants. Ann. Bot. **41:** 167–187.

Collings, G. H. 1927. The influence of boron on the growth of the soy bean plant. Soil Sci. **23:** 83–105.

Duggar, B. M. 1920. Hydrogen-ion concentration and the composition of nutrient solutions in relation to the growth of seed plants. Ann. Missouri Bot. Gard. **7:** 1–49.

Eisenmenger, W. S. 1928. Toxicity, additive effects, and antagonism of salt solutions as indicated by the growth of wheat roots. Bull. Torrey Bot. Club **55:** 261–304.

Haas, A. R. C. 1929. Toxic effect of boron on fruit trees. Bot. Gaz. **88:** 113–131.

Johnston, E. S., and W. H. Dore. 1929. The influence of boron on the chemical composition and growth of the tomato plant. Plant Physiol. **4:** 31–62.

————, **and P. L. Fisher.** 1930. The essential nature of boron to the growth and fruiting of tomato. Plant Physiol. **5:** 387–392.

Kelley, W. P., and S. M. Brown. 1928. Boron in the soils and irrigation waters of southern California and its relation to citrus and walnut culture. Hilgardia **3:** 445–458.

Mazé, P. 1919. Recherche d'une solution purement minérale capable d'assurer l'évolution complète du mais cultivé a l'abri des microbes. Ann. de l'Inst. Pasteur **33:** 139–173.

McCool, M. M. 1913. The action of certain nutrient and non-nutrient bases on plant growth. Cornell Univ. Agric. Exp. Sta. Mem. 2: 119–200.

McMurtrey, J. E., Jr. 1929. The effect of boron deficiency on the growth of tobacco plants in aërated and unaërated solutions. Jour. Agric. Res. **38:** 371–380.

Mellor, J. W. 1923. A comprehensive treatise on inorganic and theoretical chemistry. **5:** 113. London.

Osterhout, W. J. V. 1908. The value of sodium to plants by reason of its protective action. Univ. California Pub. Botany **3:** 331–337.

————. 1922. Injury, recovery, and death in relation to conductivity and permeability. 259 p. Philadelphia and London.

Reed, H. S., and A. R. C. Haas. 1924. Nutrient and toxic effects of certain ions on citrus and walnut trees with especial reference to the concentration and the pH of the medium. California Agric. Exp. Sta. Tech. Paper 17: 1–75.

Skinner, J. J., and F. E. Allison. 1923. Influence of fertilizers containing borax on the growth and fruiting of cotton. Jour. Agric. Res. **23:** 433–443.

————, **B. E. Brown, and F. R. Reid.** 1923. The effect of borax on the growth and yield of crops. U. S. Dept. Agric. Bull. 1126: 1–31.

Sommer, A. L. 1927. The search for elements essential in only small quantities for plant growth. Science **66:** 482–484.

————, **and C. B. Lipman.** 1926. Evidence on the indispensable nature of zinc and boron for higher green plants. Plant Physiol. **1:** 231–249.

Swanbeck, T. 1927. The effect of boric acid on the growth of tobacco plants in nutrient solutions. Plant Physiol. **2:** 475–486.

Trelease, S. F. 1925. Chamber with thermostatic control and rotating table for plant cultures. Bull. Torrey Bot. Club **52:** 389–395.

————, **and H. M. Trelease.** 1925. Growth of wheat roots in salt solutions containing essential ions. Bot. Gaz. **80:** 74–83.

————, **and H. M. Trelease.** 1926. Toxicity and antagonism in salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club **53:** 137–156.

Warington, K. 1926. The changes induced in the anatomical structure of *Vicia faba* by the absence of boron from the nutrient solution. Ann. Bot. **40:** 27–42.

Description of plates

The photographs of plates 1 and 2 show cultures of wheat plants at the end of eight weeks of growth in nutrient solutions supplied with varying amounts of boron in the form of boric acid and borax. The basic nutrient solution contained 0.01 m KH_2PO_4, 0.005 m $MgSO_4$, 0.005 m $CaNO_3$, and 0.00001 m $FeSO_4$. See tables 8, 9, and 10.

PLATE 1

BORIC ACID CULTURES

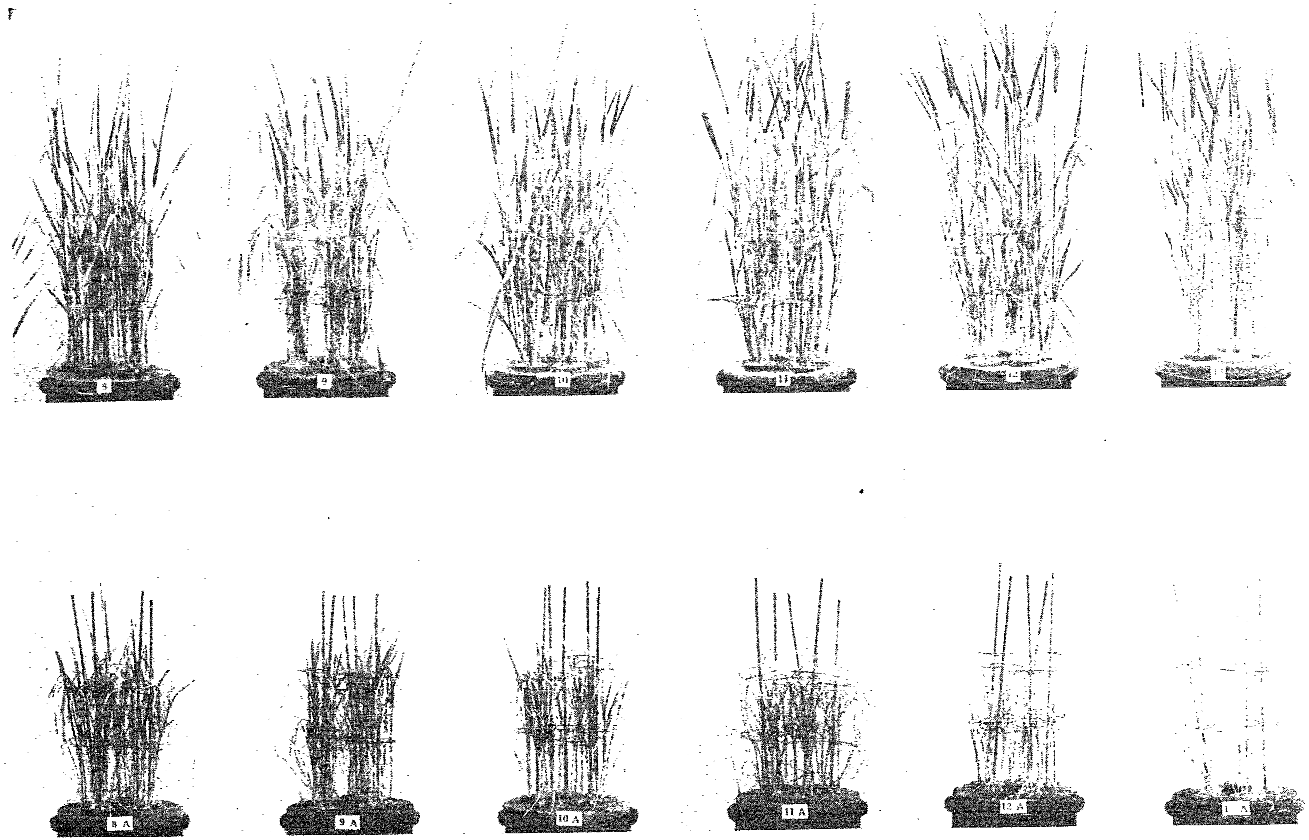
Cultures 1 to 7 were grown in renewed solutions, and cultures 1A to 7A were grown in unrenewed solutions. Cultures 1 and 1A are the boron-deficient controls for these two series. Cultures 2 to 7 and 2A to 7A represent boric acid concentrations providing 0.1 to 34 ppm. of boron. In the renewed series, the best growth is shown in culture 3 supplied with 0.3 ppm. of boron. Culture 7 shows boron toxicity. In the unrenewed series all the cultures are somewhat chlorotic.

PLATE 2

BORAX CULTURES

These cultures were grown in solutions of borax providing from 0.1 ppm. of boron (cultures 8 and 8A) to 34 ppm. (cultures 13 and 13A). Cultures 8 to 13, in which the solutions were renewed weekly, exhibit marked stimulation. Corresponding cultures 8A to 13A, in which solutions were unrenewed, exhibit marked chlorosis and depression in growth. For the degree of stimulation or depression, see control culture 1 in plate 1.


1
2
3
4
5
6
7
1 A
2 A
3 A
4 A
5 A
6 A
7 A



MORRIS: EFFECTS OF BORON ON WHEAT

A review of the American species of Daltonia

Edwin B. Bartram

(with plates 3, 4)

The genus *Daltonia* was established by Hooker and Taylor in memory of their friend, the Rev. James Dalton, Rector of Croft, in Yorkshire, whose keen interest in botany and bryology is reflected by a number of noteworthy discoveries of rare mosses and flowering plants from this district.

Curiously enough the type species, *D. splachnoides* (Sm.) Hook. & Tayl., is isolated in a few scattered localities in Ireland, while elsewhere the group is almost entirely confined to elevated tropical regions. In America the center of distribution seems to be in Cordilleran regions of Colombia and Ecuador, with extensions northward to Mexico and the West Indies, eastward to southeastern Brazil and southward to Bolivia and Chile. The reported occurrence of *D. splachnoides* in Mexico and the Antilles is probably the result of a rather hazy understanding of the type species and its American associates. *D. gracilis*, one of the most widely distributed of the American species, is undoubtedly very close to *D. splachnoides*, but the European plant should be, and I think is, clearly separable through the more incrassate upper leaf cells, the stronger, more cartilaginous border, shorter leaves, and reduced size throughout: at least no transitional forms with clearly correlated characters have been observed in any of the American collections that would tend to narrow the gap.

With a few notable exceptions the American species are closely interrelated and naturally fall into several well marked groups. No obvious distinctions have been found in either the perigonial or perichaetial leaves, the peristome, lid or calyptra, all of which seem to be fairly constant throughout the genus. Unfortunately the vegetative characters, which have been extensively relied upon to differentiate the species, are rather unstable, and although there are undoubtedly reasonable limits within which these variations can be accommodated, the question of establishing these limits and of evaluating the distinctions has often proved a delicate and tedious one.

Four species are obviously distinct: *D. macrotheca* by the elongated, almost filiform stems with distantly imbricated leaves; *D. Jamesoni* by the large, pellucid quadrate leaf cells and almost percurrent costa; *D. latolimbata* by the rounded, incrassate upper leaf cells and the band of long, narrow juxta-costal cells extending from mid-leaf to the insertion; and *D. brevinervis* by the linear, incrassate upper leaf cells extending in a central

wedge-shaped band to the insertion. Of the remaining species, one group, comprising *D. longifolia*, *D. pulvinata*, *D. braziliensis*, *D. aristata*, and *D. androgyna*, may be defined by the essentially flat leaf margins and rounded leaf cells. In this group the lamina is occasionally broadly reflexed here and there and very rarely narrowly recurved, but never regularly and consistently revolute as in all but one or two of the remaining species. The leaves of *D. stenophylla* and *D. gracilis* are sometimes nearly plane, but their smaller size and angular or elongated areolation easily distinguish them from those of *D. longifolia* and its allies, in which the leaf cells are oval and rounded.

Mitten's key, based on the leaf outline, is helpful as far as it goes; the treatment by Brotherus in both editions of Engler and Prantl by subdivisions into arbitrary groups does not do much to clarify the situation. It was at the friendly suggestion of Mrs. Britton, (who had already made a chronological list of all the American species and studied the West Indian collections) and also by means of the loan of the types not represented in the herbarium of the New York Botanical Garden, that this revision was undertaken. All the Antillean specimens and their manuscript names have been referred to South American species. Needless to say this study would have been utterly impracticable without the use of the collections which Mrs. Britton so graciously placed at my disposal. Dr. Herzog has very generously loaned his Bolivian collections, including the types of several species, together with several Brazilian specimens and a limited but highly interesting series of unnamed collections from Colombia and Bolivia, all of which have been incorporated in the present study. Through the kindness of Dr. Reimers it has been possible to examine portions of the Mueller types which rest in the Botanical Museum at Berlin-Dahlem and Dr. Lindberg has very kindly loaned type material of several South American species from the Brotherus herbarium. Such friendly coöperation is deeply appreciated and leaves a lasting sense of gratitude.

KEY TO SPECIES

Leaf margin flat
  Upper leaf cells short, oval-rhomboidal, 1:2 or less, seta stout, propagulae present. . 1. *D. pulvinata*
  Upper leaf cells oval, 1:3 or more, often more or less pitted, seta slender, propagulae wanting
    Leaves oblong-ligulate, up to 3.5 mm. long . . . . 2. *D. longifolia*
    Leaves lanceolate, 2.5–3 mm. long
      Areolation dense, upper cells up to $7 \times 18\mu$, border wide
        Seta 6–12 mm. long . . . . 3. *D. braziliensis*
        Seta 4–5 mm. long . . . . 4. *D. aristata*
      Areolation lax, upper cells up to $10 \times 30\mu$, border narrow . . . . 5. *D. androgyna*

Leaf margin revolute
 Leaves laxly imbricated, stems slender and elongated............6. *D. macrotheca*
 Leaves densely imbricated, stems shorter
  Costa ending about mid-leaf, upper cells linear..............7. *D. brevinervis*
  Costa ending $\frac{3}{4}$ or more up, upper cells not linear
   Leaves ovate, costa nearly percurrent......................8. *D. Jamesoni*
   Leaves lanceolate, costa shorter
   Basal leaf cells linear, firm, border indistinct below
    Leaves lanceolate, 0.4–0.5 mm. wide, propagulae present....9. *D. Lindigiana*
    Leaves linear-lanceolate, 0.3 mm. wide or less, propagulae usually wanting 10. *D. stenophylla*
   Basal cells oblong, border distinct to insertion
    Robust plants, leaves 3–4 mm. long, border wide
     Seta smooth
      Border 10–15 rows wide at base.....................11. *D. bilimbata*
      Border 7–9 rows wide at base.....................12. *D. pellucida*
      Seta rough above
      Juxta-costal basal cells not differentiated............13. *D. peruviana*
      Juxta-costal basal cells long linear, similar to border cells............ 14. *D. latolimbata*
    Slender plants, leaves less than 3 mm. long, border narrow
     Seta smooth
      Leaves oblong-ligulate, basal cells short oblong, firm and pellucid....... 15. *D. trachydontia*
      Leaves linear-lanceolate, basal cells linear-oblong, delicate and hyaline.....................................16. *D. tenuifolia*
     Seta rough above
      Leaves linear-lanceolate, basal cells up to 50μ long, linear-oblong.... 17. *D. gracilis*
      Leaves lanceolate, basal cells 35μ or less long, oblong.... 18. *D. ovalis*

1. Daltonia pulvinata Mitt. Jour. Linn. Soc. Bot. **12**: 398. 1869.

Autoicous. Plants densely tufted, yellowish green, glolsy. Stems up to 1.5 cm. high, simple, about 2 mm. wide with leaves, radiculose at base, with clusters of spindle shaped, septate propagulae in the leaf axils. Leaves densely imbricated, erect spreading, spirally contorted when dry, flexuose when moist, carinate with a broad median fold, oblong-ligulate, sharply acuminate, 2.5 to 3 mm. long by 0.6 mm. wide at base, margin flat, often broadly reflexed toward base but not revolute, entire or very minutely denticulate at apex, border pellucid, sharply defined, 7–10 rows wide at base, 3–4 rows at mid-leaf and 2 rows at apex; costa ending about 4/5 up, 35μ wide at base, channelled; cells of apical blade short, oval-rhomboidal, 6–8μ wide by 12–14μ long, hardly incrassate, median cells similar, basal cells short-rectangular, hyaline. Seta

stout, scarcely twisted, 5–6 mm. long, reddish, scabrous above; capsule erect, short oval, 1 mm. high by 0.7 mm. broad, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose; lid erect, rostrate; calyptra slightly scabrous above, copiously fringed, spores minutely roughened, 22–25μ in diameter.

Type Locality: Andes Bogotenses, near Bogota, Colombia.

Distribution: Colombia, Ecuador, Bolivia.

Material seen: COLOMBIA: Andes Bogotenses, prope Bogota, *Weir* (type); on branches of stunted trees by the way from Tipiguira to Pacho, 8000 ft., *Weir* (propagulae abundant).—ECUADOR: Guayrapata ad ramulos, *Spruce* (No. 566?).—BOLIVIA: Incacorral, alt. 2200 m., *Herzog 4950* in part.

Remarks: This species closely resembles both *D. longifolia* and *D. braziliensis* but appears to be distinct in the shorter, less incrassate leaf cells, the stout, short seta and larger spores. The occurrence of axillary propagulae may also be a distinctive feature. They have been found in all the specimens studied, and are especially abundant in the specimens from near Pacho, Colombia.

2. DALTONIA LONGIFOLIA Tayl. Lond. Jour. Bot. **7**: 284. 1848.

D. crispata Schimper ex Besch. Mem. Soc. Sci. Cherbourg **16**: 228. 1872. *D. robusta* Ångstr. Öfvers. K. Vet. Akad. Foerhand. **1873**[5]: 117. 1873. *D. Dussii* Broth. Symb. Ant. **3**: 426. 1903.

Autoicous. Plants in rather lax tufts, yellowish green, glossy. Stems up to 2.5 cm. high, simple or sparingly branched, 2–3 mm. wide with leaves, radiculose below. Leaves closely imbricated, erect spreading and rather spirally contorted when dry, flexuose when moist, carinate with a broad median fold, oblong-ligulate, sharply acuminate, 3 to 3.5 mm. long by 0.6 mm. wide at base; margin flat, minutely denticulate toward apex; border pellucid, sharply defined, 8–15 rows wide at base, about 4 rows at mid-leaf and 2 rows at apex; costa ending about 4/5 up, 45μ wide at base, channelled; cells of apical blade oval-oblong, 6–7μ wide by 15–25μ long, median cells similar, often arranged in oblique rows, basal cells narrowly oval to linear-rhomboidal, rather incrassate and pellucid and often lightly pitted. Seta slender, twisted to left when dry, up to 10 or 12 mm. long, reddish, scabrous above; capsule erect, oval-cylindrical, up to 1.5 mm. long by 0.8 mm. wide, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose; lid erect, rostrate, about 1 mm. long, yellowish; calyptra slightly scabrous above, copiously fringed; spores minutely roughened, 12–15μ in diameter.

Type Locality: Mt. Pichincha near Quito, Ecuador.

Distribution: Mexico, Guatemala, Haiti, Martinique, Colombia, Ecuador, Galapagos Islands, Bolivia.

Material seen: MEXICO: Huatusco, Vera Cruz, *Liebmann;* on oaks, Honey Station, Hidalgo, *Pringle 10487*.—GUATEMALA: Alta Verapaz, Cubilguitz, *Turckheim 6660*,

6661; Alta Verapaz, prope Coban, *Turckheim 6662.*—HAITI: vicinity of Furcy, *Leonard 4620b.*—MARTINIQUE: Ajoupa Bouillon, *Pere Duss 345.*—COLOMBIA: Magana, Cordillera Central, *Killip & Hazen 12092a.*—ECUADOR: Pichincha near Quito, *Jameson* (type); Autombos, *Spruce 565;* Tunguragua, *Spruce.*—GALAPAGOS ISLANDS: Chaves Island, *N. J. Anderson;* James Island, *Alban Stewart 6046a.*—BOLIVIA: Rio Pelichucho, *R. S. Williams 2751;* Santa Barbara, *R. S. Williams 1816;* Talschlucht von Tablas, *Herzog 4650;* Bergwald von Tocorani, *Herzog 4040, 4081d* in part; auf Baumasten beim Sillar, *Herzog 2696a*; Incacorral, *Herzog 5091a* in part.

Remarks: I have endeavored in all fairness to find some characters that might distinguish the various collections comprised in the synonymy of this species, but without success. *D. longifolia* is apparently an unstable type, but the variations are only relative, and may be included in the outline of a conservative specific concept. Indeed *D. pulvinata, D. longifolia, D. brazilinensis*, *D. androgyna*, and *D. aristata* form a very closely united group well defined from the other species by the essentially flat leaf margins and rounded leaf cells but not distinguished from each other by any salient characters. From a radical viewpoint the entire group might be subordinated to *D. longifolia,* but as this might tend to obscure rather than clarify our understanding of the elements involved, I have followed a middle course and tried to group the plants according to their natural affinities and geographical distribution, not, however, without considerable mental reservation. The leaf margins in the plants comprising this group are essentially flat, but occasionally the lamina is broadly reflexed, and very rarely narrowly recurved, but never consistently enough to be confused with the much larger group of species in which the margin is usually plainly and narrowly revolute.

3. DALTONIA BRAZILIENSIS Mitt. Jour. Linn. Soc. Bot. **12**: 399. 1869.

D. leucoloma Hampe, Vidensk, Medd. Nat. Foren. Kjöb. **1874**: 152. 1875.

Autoicous. Plants fulvous green, glossy. Stems up to 1.2 cm. high, more or less branched, 2–3 mm. wide with leaves, radiculose below. Leaves closely imbricated, erect and slightly spirally contorted when dry, flexuose when moist; carinate with a median fold, lanceolate, sharply acuminate, 2.5 mm. long by 0.6 mm. wide at base; margin flat, entire or very minutely denticulate above; border yellowish pellucid, 7–14 rows wide at base, about 4 rows at mid-leaf and 2 rows above; costa ending about 2/3 up, 45μ wide at base, channelled; cells of apical blade oval-rhomboidal, $6–7\mu$ broad by $14–18\mu$ long, median cells similar often oblique, basal cells rectangular and rhomboidal, all slightly incrassate. Seta slender, 6–12 mm. long, reddish, scabrous above; capsule erect, oval, up to 1.5 mm. high by 0.8 mm. broad, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose, teeth strongly trabeculate on inner side; lid erect, about 1 mm. long, yellowish; calyptra slightly scabrous above, fringed; spores minutely roughened, $14–18\mu$ in diameter.

Type Locality: Province of Minas Geraes, Brazil.

Distribution: Brazil.

Material seen: Sierra de Piedade, Minas Geraes, Brazil, *Gardner 78* (type); woods near Corritaba, *Weir;* Rio, *Glaziou 5820;* Rio Janeiro, *Glaziou 5620.*

Remarks: Leaves from the type collection of *D. braziliensis* show a variable border from 5 to 12 rows wide at the base while those from the type collection of *D. leucoloma* show a border from 7 to 14 rows wide at the base. The setae in *D. leucoloma* are rather shorter, but neither of these characters appear to be stable enough to warrant a specific distinction.

4. DALTONIA ARISTATA Geheeb & Hampe, Vidensk. Meddel. Kjøb. **1879–80:** 121. 1879.

D. Uleana C. Müll. Bull. Herb. Boiss. **6:** 111. 1898.

Autoicous and synoicous. Plants loosely tufted, yellowish green, glossy. Stems up to 1.5 cm. high, simple or branched, about 3 mm. wide with leaves, radiculose below. Leaves erect spreading, flexuose and lightly twisted when dry, flexuose when moist, ovate-lanceolate, sharply acuminate, up to 2.75 mm. long by 0.7 mm. wide at base; margin flat, entire or minutely denticulate above; border pellucid, 7 to 10 rows wide at base, 4–6 rows wide at mid-leaf and 1 or 2 rows wide above; costa ending about $\frac{3}{4}$ up, 45μ wide at base, channelled; cells of apical blade oval-rhomboidal, 6–7μ wide by 16–18μ long, median cells similar and often obliquely arranged on one side, basal cells oblong and rhomboidal, all slightly incrassate. Seta short, 4–5 mm. long, reddish, scabrous above; capsule short oval, erect, about 0.6 mm. high by 0.5 mm. wide, exothecal cells strongly collenchymatous; peristome not seen; lid conic subulate, yellowish (ex desc.); spores unknown.

Type: Prope Apiahy, San Paulo, Brazil.

Distribution: Endemic.

Material seen: BRAZIL: prope Apiahy, San Paulo, *Puiggari* (type); Catharina, Serra Geral, *E. Ule 865.*

Remarks: There is little beyond the shorter setae to separate these plants from *D. braziliensis*, and I am very doubtful if they represent anything more than a form of this species.

5. DALTONIA ANDROGYNA Geheeb & Hampe Flora **64:** 405. 1881.

Autoicous. Plants yellowish green, glossy. Stems up to 1 cm. high, simple, about 2 mm. wide with leaves, radiculose below. Leaves closely imbricated, erect and lightly spirally contorted when dry, flexuose when moist, carinate with a median fold, ovate-lanceolate, sharply acuminate, 2.5 mm. long by 0.6 mm. wide at base, margin flat, entire or very minutely denticulate above; border pellucid, 4–5 rows wide at base, about 3 rows wide at mid-leaf and 1–2 rows wide above; costa ending about 2/3 up, 40μ wide at base, channelled; cells of apical blade oblong-rhomboidal, up to 10μ wide by 20–30μ long, median

cells similar, basal cells oblong and rhomboidal becoming narrower toward costa, all rather incrassate and slightly pitted. Seta slender, about 10 mm. long, reddish, very scabrous above and rough half way down; capsule erect or inclined, oval, 1.5 mm. high by 0.9 mm. wide, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose; lid erect, 0.65 mm. high, yellowish; spores minutely roughened, 15–17 μ in diameter.

Type Locality: prope Apiahy, San Paulo, Brazil.
Distribution: Endemic.
Material seen: Brazil: prope Apiahy, San Paulo, *Puiggari 985b* (type).

Remarks: This plant appears to be distinct from *D. braziliensis* in the larger, pitted leaf cells and the narrower border and from *D. aristata* by the longer seta, larger areolation and narrower border.

6. Daltonia macrotheca Mitt. Jour. Linn. Soc. Bot. **12**: 402. 1869.

Autoicous. Plants pale, yellowish green, slightly glossy. Stems dark red, up to 4 cm. long, slender and flexuous, simple, about 1 mm. wide with leaves, radiculose at extreme base. Leaves laxly imbricated, erect, flexuose and slightly twisted when dry, erect spreading and flexuose when moist, carinate with a median fold, narrowly lanceolate, long and slenderly acuminate, 2.5 mm. long by 0.5 mm. wide at base; margin narrowly revolute on one or both sides from base nearly to apex, usually flat for a short distance below point, entire; border pellucid, 7–9 rows wide at base, 4–5 rows wide at mid-leaf and 2–3 rows wide above, confluent at apex, sharply defined below; costa ending about 2/3 up, 40 μ wide at base, channelled; cells of apical blade oval-rhomboidal, up to 7 μ wide by 20–28 μ long, median cells similar, basal cells rectangular and rhomboidal, rather lax, all lightly incrassate. Seta slender, 12–14 mm. long, dark red, scabrous above; capsule inclined, oval-cylindrical, 2.1 mm. long by 1 mm. wide, dark brown; peristome yellowish, densely papillose, the teeth with several narrow slits along the median line; lid not seen; calyptra smooth above, copiously fringed; spores slightly rough, 10–12 μ in diameter.

Type Locality: Chimborazo, Ecuador.
Distribution: Endemic.
Material seen: Ecuador: cinchona forest, Chimborazo, *Spruce* (type).

Remarks: The slender, elongated stems, laxly imbricated leaves and large capsule characterize this species clearly. It is easily segregated from *Lepidopilum chloroneuron*, with which it is entangled in the type collection, by the dark red, almost black stems, and the erect flexuose narrow leaves.

7. **Daltonia brevinervis** sp. nov.

Autoicous, male flowers about 0.7 mm. long, of 5 or 6 ovate, acute, entire perigonial bracts, the inner ecostate, the outer faintly nerved in the lower half, enclosing 2 or 3 antheridia without paraphyses. Plants in rather lax tufts, pale

green and glossy at the tips, brown below. Stems robust, up to 3 cm. long, simple or fasiculately branched, about 2 mm. wide with leaves, radiculose toward the base and often denuded of leaves in the older parts. Leaves closely imbricate, erect appressed and straight when dry, erect spreading when moist, carinate-concave without a median fold, oblong-ligulate, acute, 2 mm. long by 0.5 mm. wide at base; margin narrowly revolute from just below apex to insertion, entire; border yellowish pellucid, sharply defined at base, merging with the lamina cells about 1/3 up and indistinct above, 6–8 rows wide at base; costa slender, flat and indistinct, about 30μ wide at base, blending with the elongated lamina cells about mid-leaf; cells of apical blade linear, about 5μ wide by 40–50μ long, yellowish pellucid and rather obscure, slightly incrassate, shorter toward the margins and extreme apex, median cells similar and extending in a V shaped band to the base of the costa, basal cells between the median band and margin oval and short rectangular with rounded ends, 6–8μ wide by 12–24μ long, pellucid to hyaline. Seta slender, about 12 mm. long, usually scabrous throughout; capsule erect or slightly inclined, short oval, about 1 mm. high by 0.8 mm. wide, dark brown; peristome yellowish, densely papillose (fruit all old); lid not seen; calyptra conical, smooth above, copiously fringed; spores roughened, about 15μ in diameter.

Type: an der Rinde von Vorpostenbaumchen, Paramo El Boqueron near Bogota, Colombia, 3300 meters, *K. Troll 2176* in 1929. Com. Herzog.

Distribution: Known only from the type locality.

Remarks: This very interesting species was received from Dr. Herzog with other specimens of *Daltonia* from the same region. It seems to have no close affinity with any other known species, and is unique in the short nerve and linear areolation of the upper lamina, which converges in a wedge-shaped band to the base of the nerve. The area of short, hyaline cells between this band and the border is clearly differentiated, and ends above in a somewhat acute angle near the border. The type is deposited in the herbarium of the writer.

8. DALTONIA JAMESONI Tayl. Lond. Jour. Bot. 7: 283. 1848.

Autoicous. Plants in compact tufts, yellow, slightly glossy. Stems robust, stiffly erect, up to 5 cm. long, simple or with few erect branches, about 1 mm. wide with leaves, densely radiculose and matted rogether in lower parts. Leaves closely imbricated, appressed and lightly twisted when dry, closely appressed with flexuose tips when moist, carinate with a broad median fold, broadly ovate, sharply acuminate, 2 mm. long by 0.8 mm. wide, margin narrowly revolte, entire; border yellowish pellucid, narrow, sharply defined, 3–5 rows wide at base, about 3 rows at mid-leaf and 2 rows wide above; costa faint, usually obscured by the median fold, about 30μ wide at base, flat, ending in acumen just below point; upper and median leaf cells quadrate and short rectangular, pellucid, somewhat incrassate, about 15μ wide by 15–25μ long,

basal cells more elongate up to 50μ long. Seta dark red, 8–12 mm. long, scabrous above; capsule erect, oval-cylindrical, 1.4 mm. high by 0.5 mm. wide, dark red, exothecal cells strongly collenchymatous; peristome pale yellow, densely papillose; lid erect, rostrate, 1 mm. long, yellowish; calyptra scabrous above, copiously ciliate; spores roughened, 20–25μ in diameter.

D. JAMESONI var. LAEVIS Herzog, Bibl. Bot. 87: 128. 1926.

Distinguished from the type by the seta almost smooth throughout.

Type Locality: Ecuador, Mt. Pichincha.

Distribution: Ecuador, Bolivia (var.).

Material seen: ECUADOR: summit of Mt. Pichincha on hillocks of Bolax *Jameson* in 1847 (type).—BOLIVIA: an feuchten felsen der Cerros de Malagá, ca. 4000 m., *Herzog 4415* (var.).

Remarks: The broad leaves, large subquadrate, pellucid leaf cells and almost percurrent costa separate this plant unmistakably from any of its associates.

9. DALTONIA LINDIGIANA Hampe, Ann. Sci. Nat. Bot. V. **4**: 363. 1866.

D. irrorata Mitt. Jour. Linn. Soc. Bot. **12**: 399. 1869. *D. Stewartii* R. S. Williams, Bryologist **27**: 38. 1924.

Autoicous. Plants in rather compact tufts, golden brown, glossy. Stems usually robust, erect or ascending, up to 3 cm. long, usually branched, about 2 mm. wide with leaves, sparingly radiculose below, with axillary, spindle shaped, septate propagulae. Leaves closely imbricated, erect and straight or slightly flexuose when dry, erect-spreading when moist, carinate with a median fold, narrowly lanceolate, acuminate, up to 4 mm. long by 0.5 mm. wide at base; margin narrowly revolute on one or both sides, entire; border pellucid, rather indistinct, blending with the elongated basal cells below, 8–10 rows wide at base, 4–5 rows wide at mid-leaf and 1–2 rows wide above; costa about 40μ wide at base obscured by the median fold, ending about 4/5 up; cells of apical blade narrowly rhomboidal or lenticular, up to 8μ wide by 25–45μ long, median cells similar but rather narrower, basal cells linear, up to 60μ long, rather incrassate throughout with firm, pellucid walls. Seta 10–12 mm. long, shorter in reduced forms, dark red, scabrous above and sometimes roughened to or below the middle; capsule erect, short oval, 1–1.25 mm. long by 0.7 mm. wide, dark brown, exothecal cells rounded, hexagonal, thick walled but not strongly collenchymatous except near the rim; peristome yellowish, densely papillose, teeth usually with several apertures along the median line; lid erect, rostrate, 0.75 mm. long, yellowish; calyptra slightly scabrous above, copiously fringed; spores roughened, 12–18μ in diameter.

Type Locality: Colombia, Boqueron.

Distribution: Colombia, Galapagos Islands, Ecuador.

Material seen: COLOMBIA: Boqueron, 2100 m., *Lindig 2023* (type); Boqueron prope Bogota, *Weir 193, 294, 336, 338;* Paramo El Boqueron bei Bogota, *K. Troll*

2180d, 2185.—GALAPAGOS ISLANDS: Chatham Island, *Alban Stewart 2782.*—ECUADOR: Andes Quitenses, Cayembe, *Spruce.*

Remarks: Evidently Mitten was unaware of Hampe's species, as there is no reference to it in his Musc. Austro-Am. published in 1869. Lindig's type collection and the subsequent collections of Weir and Troll all come from the Paramo Boqueron near Bogota, and are identical in every essential particular. *Weir 336* and *Troll 2180d* seem to be only stunted forms without any structural differences, and the plants collected by Stewart in the Galapagos Islands are likewise inseparable from those of the type locality. The species may be recognized by the elongated, firm basal cells blending with the border, which is consequently ill-defined below, and by the axillary propagulae. *D. stenophylla* is a smaller plant with narrower leaves. Some forms of *D. Lindigiana* are uncomfortably close to *D. gracilis*, in fact the four species *D. stenophylla*, *D. gracilis*, *D. Hampeana* and *D. ovalis* form a rather compact group of closely related forms that are often difficult to delimit sharply, but for the present it does not seem that any constructive result will be gained by further condensation.

10. DALTONIA STENOPHYLLA Mitt. Jour. Linn. Soc. Bot. **12:** 402. 1869.

D. aristifolia Bartr. Cont. U. S. Nat. Herb. **26:** 99. 1928; *D. Fendleri* C. Müller Linnaea **42:** 491. 1879; *D. tenella* Broth. Act. Soc. Sci. Fenn. no. 5. 1897.

Autoicous. Plants in small tufts, pale green, glossy. Stems short and slender, simple or branched, 5–12 mm. high, 1–2 mm. broad with leaves, radiculose below. Leaves closely imbricated, straight or lightly twisted when dry, carinate with a narrow median fold, narrowly linear-lanceolate, subulate acuminate, up to 3 mm. long by 0.3 mm. wide at base; margin narrowly revolute, entire; border pellucid, rather indistinct below, 5–8 rows wide at base, 4–6 rows wide at mid-leaf and 2 rows wide above; costa about 40μ wide at base channelled, ending about 4/5 up; cells of apical blade lenticular, about 7μ wide and up to 45μ long, median cells similar, basal cells linear-oblong, up to 70μ long, firm throughout with slightly thickened, pellucid walls. Seta up to 9 mm. long, often shorter, reddish, slightly scabrous above; capsule erect, narrowly oval, up to 1.2 mm. high by 0.5 mm. wide, dark brown, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose; lid erect, rostrate, 0.75 mm. long, yellowish; calyptra nearly smooth above, fringed; spores minutely roughened, $10–12\mu$ in diameter.

Type Locality: Mt. Tunguragua, Ecuador.

Distribution: Jamaica; St. Vincent; Costa Rica; Venezuela; Ecuador; Brazil.

Material seen: JAMAICA: Dollwood, St. Catharine's Peak, *Nichols 94;* Blue Mt. Peak, *Jaderholm 7420.*—ST. VINCENT: *Guilding.*—COSTA RICA: Volcan de Turrialba, *Standley 35156a.*—VENEZUELA: Valencia, *Fendler 131.*—BRAZIL: Caraca, Minas Geraes, *Wainio;* Alto de Serra, San Paulo, *A. Gehrt 466, 469,* com. Herzog.—ECUADOR: Mt. Tunguragua, *Spruce 568* (type); Llalla, *Spruce 567.*

Remarks: The plants included here vary in the degree of robustness and length of setae but they all have in common the nearly erect, subulate-acuminate leaves, elongated pellucid leaf cells and rather narrow, poorly defined border below. Axillary, septate propagulae, similar to those found in *D. Lindigiana* but small, occur sparingly in no. 466 from Brazil, but otherwise the plants of this collection are indistinguishable from those included in the specific concept of *D. stenophylla*.

11. DALTONIA BILIMBATA Hampe Linnaea **32**: 151. 1863.

D. compressa Mitt. Jour. Linn. Soc. Bot. **12**: 400. 1869.

Autoicous. Plants densely tufted, yellowish green above, brown below, glossy. Stems up to 1.5 cm. high, rather robust, simple, about 5 mm. wide with leaves, radiculose below. Leaves crowded, erect-spreading, slightly flexuose, carinate with a median fold, oblong-lanceolate, acuminate, 4 mm. long by 0.5 mm. wide at base; margin narrowly revolute on one or both sides, entire; border pellucid, very broad and distinct in the lower half and occupying 1/2 or more of the leaf base, 12–15 rows wide at base, 7–9 rows wide at mid-leaf and 2–3 rows wide above; costa about 45μ wide at base, ending about 4/5 up; cells of apical blade oval-hexagonal to oval-rhomboidal, about 8μ wide by $25–30\mu$ long, median cells similar, basal cells rather lax, rectangular and linear-oblong, all rather thin walled and hyaline. Seta slender, reddish, up to 14 mm. long, indistinctly roughened or smooth above; capsule inclined, narrowly oval, about 2 mm. long by 0.9 mm. wide, dark brown, exothecal cells collenchymatous in upper half of urn, uniformly thickened below; peristome normal; lid erect, rostrate, 1.5 mm. long, yellowish; calyptra slightly rough above, fringed; spores roughened, $20–25\mu$ in diameter.

Type Locality: Bogota, Colombia.

Distribution: Colombia, Ecuador.

Material seen: COLOMBIA: Bogota, Monserate, *Lindig* (type); Grenze der 'Ceja' gegen den Paramo, *K. Troll 2028;* Andes Bogotenses, *Weir 349.*—ECUADOR: Mt. Pichincha, *Spruce 563.*

Remarks: The robust habit, long leaves and wide border clearly distinguish this species from any others in the group with revolute leaf margins. The margin in this species varies somewhat, being sometimes narrowly revolute on one side and broadly recurved on the other or even flat toward the base, but never plane throughout as in *D. longifolia* and its allies.

12. DALTONIA PELLUCIDA Herzog, Bibl. Bot. 87: 128. 1916.

Autoicous. Plants in small, dense tufts, yellowish green above, brown below, glossy. Stems up to 2.5 cm. high, about 2.5 mm. wide with leaves, simple or branched, densely radiculose below. Leaves crowded, erect and spirally twisted when dry, erect-flexuose when moist, carinate with a median fold,

oblong-ligulate, up to 4 mm. long by 0.75 mm. wide at base; margin narrowly revolute, more broadly so on one side than the other, entire; border pellucid, well defined, 7–9 rows wide at base, 5–7 rows wide at mid-leaf and 2 rows wide above; costa 40μ wide at base, ending about 4/5 up; cells of apical blade oval-hexagonal, scarcely incrassate, 7–8μ wide by 15–25μ long, median cells similar but more oblong, basal cells oblong and linear-oblong, all pellucid. Seta up to 1 cm. long, slender, reddish, smooth; capsule oval, 1.5 mm. high by 1 mm. wide, dark brown; peristome, lid and calyptra unknown; spores roughened, about 15μ in diameter.

Type Locality: Comarapa, Bolivia.

Distribution: Endemic.

Material seen: Bolivia: Auf Baumästen im Nebelwald über Comarapa, ca. 2600 m., *Herzog 4214* (type).

Remarks: This plant together with *D. peruviana* and *D. bilimbata* form a natural little group characterized by the robust habit and broadly bordered leaves. *D. pellucida* may be distinguished from *D. peruviana* by the smooth seta, and from *D. bilimbata* by the narrower border and shorter, broader capsules.

13. Daltonia peruviana Mitt. Jour. Linn. Soc. Bot. **12**: 401. 1869.

Autoicous. Plants densely tufted, pale yellowish green above, brown below, slightly glossy. Stems rather robust, up to 2.5 cm. high, about 2 mm. wide with leaves, cuspidate at the tips, radiculose below. Leaves crowded, erect, flexuose and twisted when dry, carinate with a median fold, oblong-lanceolate, acuminate, up to 3 mm. long by 0.8 mm. wide at base; margin narrowly revolute, entire; border pellucid, broad and well defined, 12–15 rows wide at base, 7–9 rows wide at mid-leaf and 2–3 rows wide above; costa 35μ wide at base, ending about 4/5 up; cells of apical blade oval-hexagonal, 7μ wide by 15–20μ long, not incrassate, pellucid, median cells similar but more hyaline, basal cells oblong, hyaline. Seta slender, 8 mm. long, reddish, rough above; capsule erect or inclined, oval, 1 mm. high by 0.5 mm. wide, brown; peristome, lid and calyptra unknown(capsules all old).

Type Locality: Cordillera de Raneo, Sachapata, Peru.

Distribution: Endemic.

Material seen: Peru: Cordillera de Raneo, Sachapata, *Lechler* (type).

Remarks: The wide border and hyaline areolation suggest an approach to *D. bilimbata*, but that species is even more robust with longer, more broadly bordered leaves and in addition has an almost smooth seta and much larger capsules.

14. Daltonia latolimbata Broth. Bibl. Bot. 87: 129. 1916.

Autoicous? Plants in small tufts, golden green above, pale brown below, glossy. Stems rather robust, about 2 cm. high, simple or branched, 3–4 mm.

wide with leaves, radiculose below. Leaves crowded erect-spreading and lightly twisted when dry, more widely spreading and somewhat flexuose when moist, carinate with a small median fold, oblong-lanceolate, gradually acuminate, up to 4 mm. long by 0.9 mm. wide at base; margin narrowly revolute, often merely reflexed or even flat in acumen, entire; border pellucid, rather indistinct, 12–15 rows wide at base, 7–9 rows wide at mid-leaf and 2–3 rows wide above; costa 45μ wide at base, ending about 4/5 up; cells of apical blade with oval lumens, incrassate, pellucid, about 7μ wide by 20μ long, median cells similar but more elongated becoming linear toward costa, basal cells between border and central band linear-oblong and linear-rhomboidal, incrassate and pellucid, a band 8 or 10 rows wide on either side of costa very long and narrow, similar to the border cells. Seta about 7 mm. long, slender, reddish, slightly rough above; capsule erect, oval, about 1.1 mm. high; peristome, lid and calyptra unknown; spores (ex desc.) 25μ in diameter.

Type Locality: Incacorral, Bolivia.
Distribution: Endemic.
Material seen: Bolivia: Incacorral, 2200 m., *Herzog 4950a* (type).

Remarks: The rounded, incrassate cells of the upper lamina distinguish this species at once from any others in the group of robust plants with broadly bordered leaves and revolute margins. The band of long, narrow cells next to the costa extending from the base to above mid-leaf is a very marked character shared by only one other species, *D. brevinervis*, which is distinguished at a glance from *D. latolimbata* by the linear upper leaf cells, short nerve and narrow border.

15. DALTONIA TRACHYDONTIA Mitt. Jour. Linn. Soc. Bot. **12**: 400. 1869.

D. subirrorata Broth. Bibl. Bot. 87: 129. 1916. *D. Valdiviae* Herzog, Hedwigia **64**: 15. 1923.

Autoicous. Plants in small tufts, fulvous green, glossy. Stems up to 1 cm. high, about 1 mm. wide with leaves, radiculose below. Leaves crowded, erect flexuose and twisted when dry, erect-spreading and flexuose when moist, carinate with a broad median fold, oblong-ligulate, acuminate, up to 3 mm. long by 0.4 mm. wide at base; margin narrowly revolute, often more broadly so on one side, entire; border pellucid, narrow but well defined, 3–5 rows wide at base, 2–3 rows wide at mid-leaf and 1–2 rows wide above; costa slender, obscured by median fold, 30μ wide at base, ending about 3/4 up; cells of apical blade oval-hexagonal, not incrassate, rather pellucid, about 7μ wide by 14–18μ long, median cells similar, more rhomboidal, basal cells oblong, up to 25μ long. Seta up to 1 cm. long, reddish, smooth or nearly so; capsule erect, oval, up to 1.5 mm. long by 0.5 mm. wide, peristome yellowish, densely papillose; lid rostrate, erect, 0.75 mm. long, yellowish; calyptra smooth above; spores roughened, 12–16μ in diameter.

Type Locality: Cayembe, Andes Quitenses, Ecuador.

Distribution: Ecuador, Bolivia, Chile.

Material seen: ECUADOR: Cayembe, Andes Quitenses, cum *D. ovalis*, *Jameson* (type).—BOLIVIA: Sorata, 2500 m., *Williams 2942;* Aucoma, Cordillera Real, ca. 4000 m., *K. Troll 27*.—CHILE: Arique, Isla de Tejas, bei Valdivia, *Herzog 5268*.—BOLIVIA: Incacorral, *Herzog 5091a* in part.

Remarks: Distinguished from *D. tenuifolia* by the broader, more ligulate leaves, wider capsule and especially by the rather incrassate, pellucid leaf cells which are short and firm at the base. Having been unable to separate the Bolivian plants described by Brotherus from those representing the type collection of *D. trachydontia* I have no alternative but to include them under the older specific name. I have also been tempted to refer *D. Valdiviae* to synonymy, as it seems to be only a reduced form differing from the type in no important particular but the shorter seta. This is a variable factor at best, and hardly strong enough alone to merit a specific distinction.

16. DALTONIA TENUIFOLIA Mitt. Jour. Linn. Soc. Bot. **12:** 402. 1869.

Autoicous. Plants in small tufts, sordid to bright green, glossy. Stems slender, up to 7 mm. high, simple or branched, 1–1.5 mm. wide with leaves, radiculose below. Leaves crowded, erect, flexuose and lightly twisted when dry, erect-spreading and flexuose when moist, carinate, linear-lanceolate, slenderly acuminate, up to 2.5 mm. long by 0.3 mm. wide at base; margin narrowly revolute on one or both sides toward base, usually flat in acumen, entire; border pellucid, rather narrow, 4–6 rows wide at base, 3–4 rows wide at mid-leaf and 1–2 rows wide above; costa 40μ wide at base, obscured by the narrow median fold, ending about 4/5 up; cells of apical blade oval-hexagonal, lax, not incrassate, up to 12μ wide by 25μ long, median cells more rhomboidal, basal cells linear-oblong, thin walled, delicate and hyaline. Seta up to 6 mm. long, reddish, smooth; capsule erect, oval-cylindrical, 1–1.5 mm. high by 0.5 mm. wide, peristome yellowish, densely papillose; lid rostrate, erect, 0.6 mm. long, yellowish; calyptra smooth above, copiously fringed; spores roughened, $10–12\mu$ in diameter.

Type Locality: Pallatanga, Andes Quitenses, Ecuador.

Distribution: Costa Rica, Ecuador, Bolivia.

Material seen: COSTA RICA: San Jose, Prov. San Jose, *M. Valerio 205a.*—ECUADOR: Pallatanga, ad arbores, 6000 ft., *Spruce 561* (type).—BOLIVIA: Quebrada de Pacona, 2800 m., *Herzog 5149.*

Remarks: For distinctions between this species and *D. trachydontia* refer to notes under the latter plant.

17. DALTONIA GRACILIS Mitt. Jour. Linn. Soc. Bot. **12:** 402. 1869.

D. Wallisii C. Müll. Flora **58:** 550. 1875; *D. ocanniana* C. Müll. Flora **58:**

551. 1875; *D. lorifolia* C. Müll. Flora **58**: 550. 1875; *D. minutifolia* C. Müll. Nuov. Giorn. Bot. Ital. 4: 148. 1897; *D. Hampeana* Geheeb, Vidensk. Meddel. Kjøb. **1879–1880**: 122. 1879; *D. curvicuspes* C. Müll. Hedwigia **39**: 268. 1900; *D. Krauseana* C. Müll.

Autoicous and synoicous. Plants in small tufts, yellowish or fulvous green, glossy. Stems slender, up to 1 cm. high, about 1 mm. wide with leaves, radiculose below. Leaves crowded, erect, flexuose-twisted when dry, flexuose when moist, carinate with a narrow median fold, linear-lanceolate, up to 2.5 or 3 mm. long by 0.4 mm. wide at base; margin narrowly revolute on one or both sides, sometimes flat toward base, entire; border pellucid, well defined, 6–8 rows wide at base, 3–4 rows wide at mid-leaf and 2 rows wide above; costa 30μ wide at base, ending about 4/5 up; cells of apical blade lenticular or narrowly rhomboidal up to 7μ wide by 24μ long, slightly incrassate, pellucid, median cells similar, rhomboidal and linear rhomboidal, basal cells linear-oblong, hyaline. Seta slender, about 6 mm. long, reddish, scabrous above and sometimes rough half way down; capsule erect or inclined, oval-cylindrical, up to 1.1 mm. high by 0.5 mm. wide, dark brown, exothecal cells strongly collenchymatous; peristome yellowish, densely papillose; lid erect, rostrate, 0.75 mm. long, yellowish; calyptra slightly rough above, fringed; spores roughened, $12–14\mu$ in diameter.

Type Locality: Canelos, Andes Quitenses, Ecuador.

Distribution: Costa Rica, Panama, Colombia, Ecuador, Peru, Bolivia, Chile, Brazil.

Material seen: COSTA RICA: Candelaria in foliis arboreum inter Hepaticas, *Oersted.*—PANAMA: Humid forest between Alto de las Palmas and top of Cerro de la Horqueta, Chirique, *Pittier 3252* in part.—COLOMBIA: Sibati to El Penon, *Rusby & Pennell;* Ocanna and Santa Isabel, *Wallis.*—ECUADOR: in sylva Canelos, Andes Quitenses, 3000 ft., *Spruce 560* (type).—PERU: Tatanara, *Lechler.*—BOLIVIA: Bergwald von Tocorani, *Herzog 4042;* Incacorral, *Herzog 5021;* Prov. Cochabamba prope Choquecamata, *Germain;* Rio Tocorani, *Herzog 4081d* in part; Incacorral *Herzog 18;* Estradillas, Prov. Cochabamba, *Herzog.*—CHILE: Valdivia, *Krause.*—BRAZIL: prope Apiahy, San Paulo, *Puiggari;* Serra Ouro Preto, Minas Geraes, *Ule 1438.*

Remarks: The plants referred here vary considerably in size but there are no structural differences that can be correlated with the smaller forms described by Müller under the names of *D. lorifolia* and *D. minutifolia* and it seems highly probable that all these collections are merely variants of one specific type. The margins are sometimes flat but not consistently so, as leaves with plane margins and others with one or both margins narrowly revolute are found on the same plant. There is nothing to distinguish either *D. Wallisii* or *D. ocanniana* from each other or from the type, and although *D. minutifolia* is a smaller plant more nearly resembling *D. splachnoides* of Europe, I have been unable to satisfactorily separate it from *D. gracilis.* This species has a broad distribution, and no doubt includes

D. Hampeana and *D. curvicuspes* of Brazil, in which the upper leaf cells are more elongated and the seta not quite so rough, but not uniformly enough to establish any satisfactory separation.

18. DALTONIA OVALIS Tayl. Lond. Jour. Bot. **5**: 66. 1846.

Autoicous. Plants up to 12 mm. high, about 1.5 mm. wide with leaves, radiculose below. Leaves crowded, erect-flexuose and slightly twisted when dry, flexuose when moist, carinate with a median fold, lanceolate, up to 1.75 mm. long by 0.27 mm. wide at base; margin narrowly revolute on one or both sides, sometimes flat toward base, entire; border pellucid, rather narrow, 4–5 rows wide at base, 3–4 rows wide at mid-leaf and 2 rows wide above; costa 30μ wide at base, ending about 3/4 up; cells of apical blade oval and oval-rhomboidal, 7μ wide by about 20μ long, slightly incrassate, pellucid, median cells similar, basal cells oblong and rhomboidal, about 1: 3. Seta slender, up to 14 mm. long, reddish, roughened above; capsule inclined, oval, dark brown, 1.1 mm. high by 0.5 mm. wide, exothecal cells collenchymatous near the rim and uniformly thickened below; peristome yellowish, densely papillose; lid rostrate, erect, 0.8 mm. long, yellowish; calyptra slightly rough above; spores roughened, 17–20μ in diameter.

Type Locality: Cayembe, Andes Quitenses, Ecuador.

Distribution: Endemic.

Material seen: Ecuador: Cayembe, Andes Quitenses, on shrubs, 1400 meters, *Jameson* (type).

Remarks: This species is known only from the type collection and may be distinguished from *D. gracilis*, which it approaches very closely, by the broader leaves, shorter basal cells and longer seta.

DOUBTFUL AND EXCLUDED SPECIES

DALTONIA CUCULLATA Hampe Linnaea **32**: 151. 1863. It is impossible to locate this species definitely from the description and no specimens have been available for comparison.

DALTONIA SERICEA Schimper, Ms. The specimen under this name in the herbarium of the New York Botanical Garden is mostly *Leucomnium attenuatum* Mitt., with some strands of *Taxithelium planum*. No *Daltonia* plants were found.

DALTONIA LONGICUSPIDATA C. Müll. Bull. Herb. Boiss. **5**: 201. 1897. What is supposed to be a part of the type collection, ex Hb. Brotherus, in the herbarium of the New York Botanical Garden does not agree with the description or the type locality cited by Müller. As no further material is available for comparison it seems best to exclude this species until its status can be definitely determined.

ALPHABETICAL LIST OF SPECIES

Daltonia androgyna Geh. & Hampe
Daltonia ariquensis Schimper = *D. gracilis* Mitt.
Daltonia aristata Geh. & Hampe
Daltonia aristifolia Bartr. = *D. stenophylla* Mitt.
Daltonia bilimbata Hampe
Daltonia binervis Hampe = *Lepidopilum daltoniacum* Ann. Sci. Nat. Bot. V. 4: 364. 1866.
Daltonia braziliensis Mitt.
Daltonia brevinervis Bartr.
Daltonia brevicuspidata Broth. = *D. longifolia* Tayl.
Daltonia compressa Mitt. = *D. bilimbata* Hampe
Daltonia crispata Schimper = *D. longifolia* Tayl.
Daltonia cucullata Hampe, excluded
Daltonia curvicuspes C. Müll. = *D. gracilis* Mitt.
Daltonia Dussii Broth. = *D. longifolia* Tayl.
Daltonia Fendleri C. Müll. = *D. stenophylla* Mitt.
Daltonia gracilis Mitt.
Daltonia Hampeana Geh. = *D. gracilis* Mitt.
Daltonia irrorata Mitt. = *D. Lindigiana* Hampe
Daltonia Jamesoni Tayl.
Daltonia Krauseana C. Müll. = *D. gracilis* Mitt.
Daltonia latolimbata Broth.
Daltonia leucoloma Hampe = *D. braziliensis* Mitt.
Daltinia Lindigiana Hampe
Daltonia longifolia Tayl.
Daltonia longicuspidata C. Müll. excluded
Daltonia lorifolia C. Müll. = *D. gracilis* Mitt.
Daltonia macrotheca Mitt.
Daltonia minutifolia C. Müll. = *D. gracilis* Mitt.
Daltonia ocanniana C. Müll. = *D. gracilis* Mitt.
Daltonia ovalis Tayl.
Daltonia pellucida Herz.
Daltonia peruviana Mitt.
Daltonia pulvinata Mitt.
Daltonia robusta Ångstr. = *D. longifolia* Tayl.
Daltonia sericea Schimper, excluded.
Daltonia stenophylla Mitt.
Daltonia Stewartii R. S. Williams = *D. Lindigiana* Hampe
Daltonia subirrorata Broth. = *D. trachydontia* Mitt.
Daltonia tenella Broth. = *D. stenophylla* Mitt.
Daltonia tenuifolia Mitt.
Daltonia trachydontia Mitt.
Daltonia Uleana C. Müll. = *D. aristata* Geh. & Hampe
Daltonia Valdiviae Herz. = *D. trachydontia* Mitt.
Daltonia Wallisii C. Müll. = *D. gracilis* Mitt.

BUSHKILL, PIKE COUNTY
PENNSYLVANIA

Explanation of plates 3, 4

The figures in the following plates are all drawn from plants representing the type collections. The following symbols are used uniformly throughout the plates:

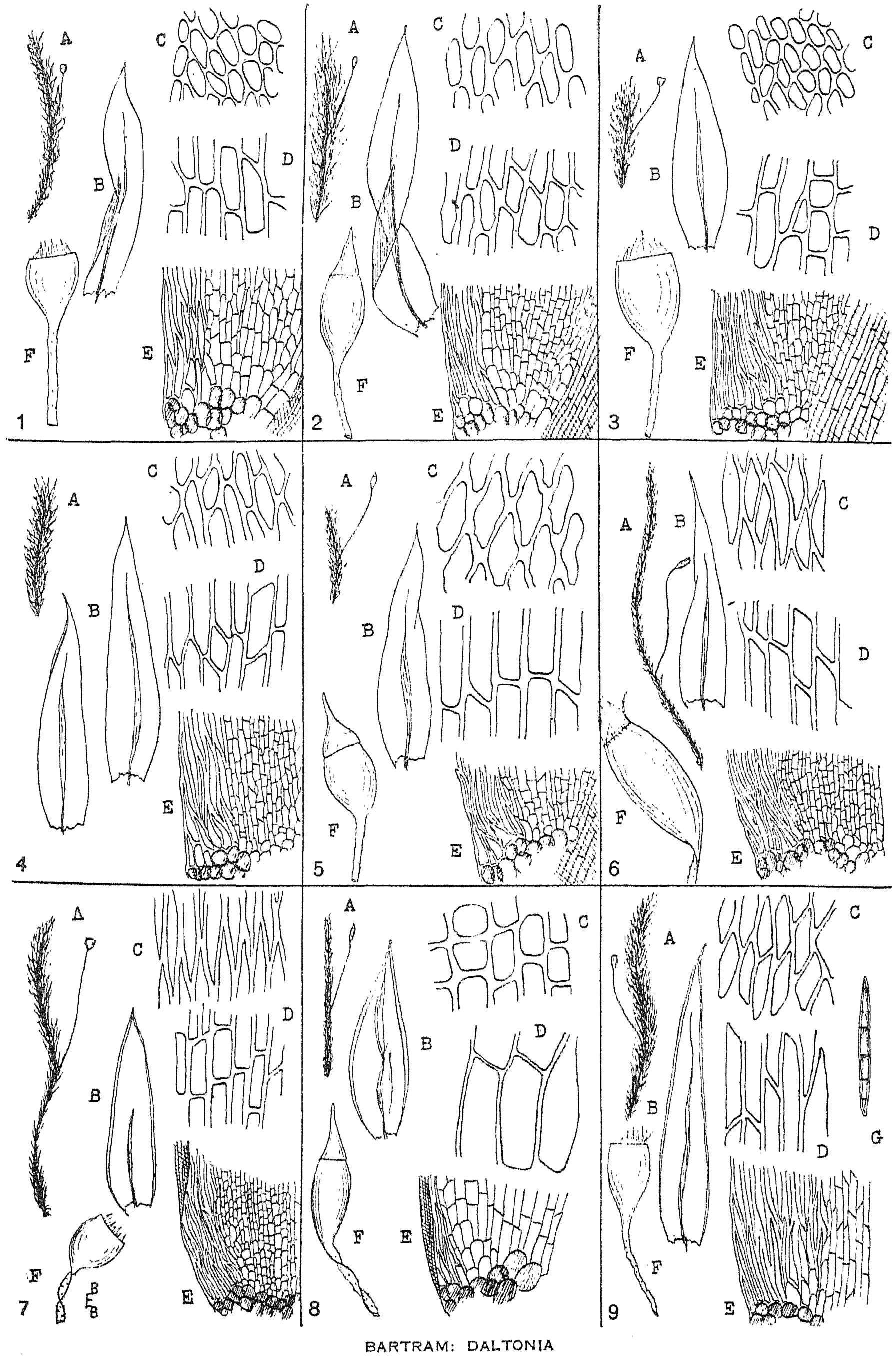
A—Plant ×2.
B—Leaf ×18.
C—Upper leaf cells ×400.
D—Basal leaf cells ×400.
E—One side of leaf base ×160.
F—Capsule ×12.
G—Propagula ×160.

Plate 3

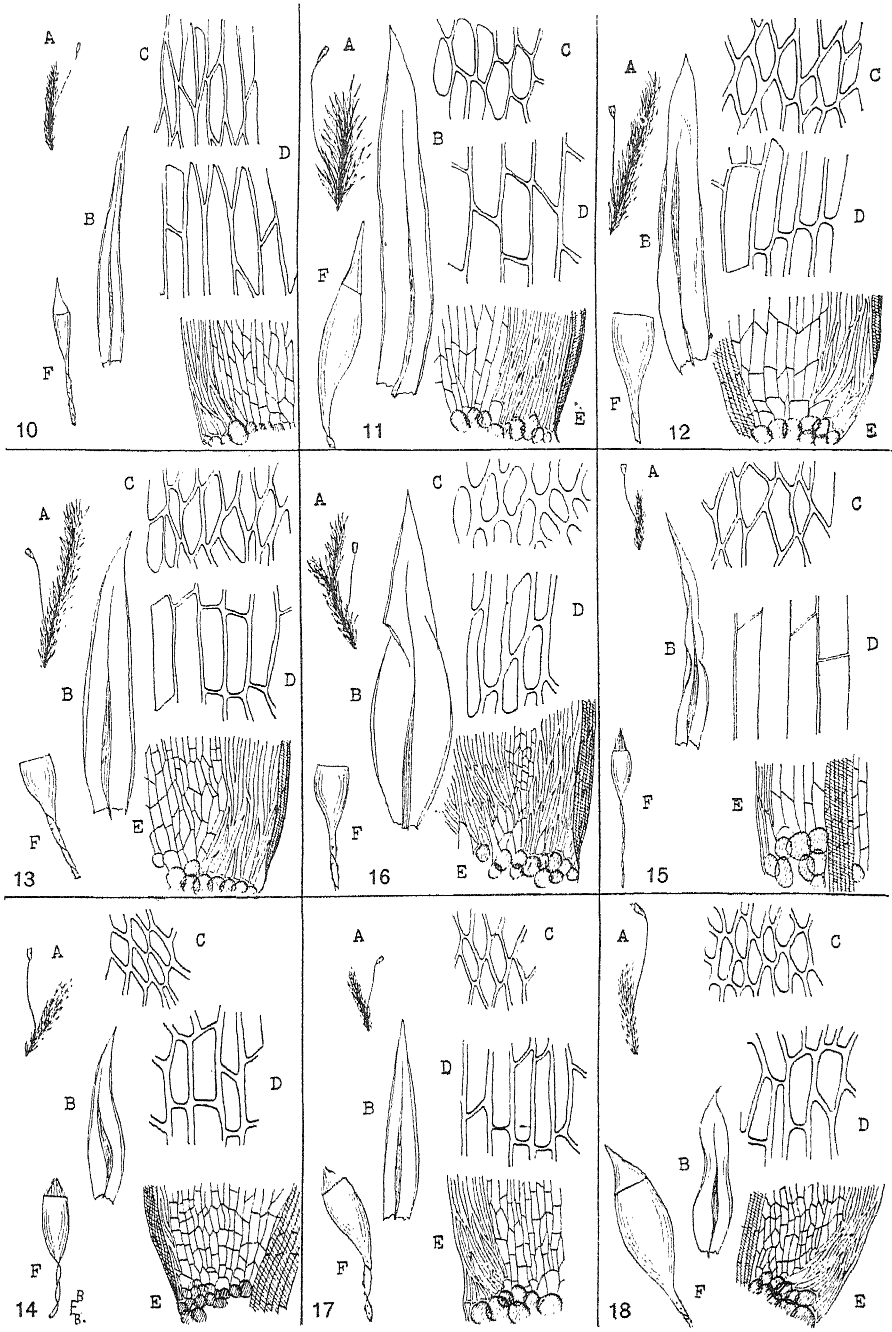
Fig. 1. Daltonia pulvinata Mitt.
Fig. 2. Daltonia longifolia Tayl.
Fig. 3. Daltonia braziliensis Mitt.
Fig. 4. Daltonia aristata Geheeb & Hampe
Fig. 5. Daltonia androgyna Geheeb & Hampe
Fig. 6. Daltonia macrotheca Mitt.
Fig. 7. Daltonia brevinervis Bartram
Fig. 8. Daltonia Jamesoni Tayl.
Fig. 9. Daltonia Lindigiana Hampe

Plate 4

Fig. 10. Daltonia stenophylla Mitt.
Fig. 11. Daltonia bilimbata Hampe
Fig. 12. Daltonia pellucida Herz.
Fig. 13. Daltonia peruviana Mitt.
Fig. 14. Daltonia latolimbata Broth.
Fig. 15. Daltonia trachydontia Mitt.
Fig. 16. Daltonia tenuifolia Mitt.
Fig. 17. Daltonia gracilis Mitt.
Fig. 18. Daltonia ovalis Tayl.



BARTRAM: DALTONIA



BARTRAM: DALTONIA

Nomenclatural notes[1]

H. C. SKEELS

In a recent issue of *Gentes Herbarum* (vol. 2, fasc. 4, p. 170, 1930) Dr. L. H. Bailey lists the binomial *Eugenia paniculata* Banks as published by Gaertner, 'Fruct. et Sem. Plant. i, 167 t. XXXIII, no. 1 (1788),' and cites as a synonym *Syzygium paniculatum* Gaertn. l. c. This is an exact reversal of the facts. Gaertner published the binomial *Syzygium paniculatum* and cited as a synonym '*Eugenia paniculata* Hort. Sicc. Banks.' This is only a name on an herbarium sheet and has no more standing in botanical nomenclature than the two names *Eugenia Hookeri* and *E. Hookeriana* listed by Dr. Bailey as 'Hort.' *Eugenia paniculata* Lam., published in 1789 for a different species, as correctly reported by Dr. Bailey, is a tenable name for the species Lamarck described and precludes the use of that binomial for any other species in *Eugenia*. Similarly, *Eugenia myrtifolia* Salisb., 1796, precludes the use of *E. myrtifolia* Sims, 1821, for the species under discussion. The first tenable name so far known for this species is *Eugenia australis* Wendl., and this is the name at present used by the Department of Agriculture. If Dr. Bailey considers the form horticulturally known as *Eugenia Hookeri* distinct enough to deserve a subspecific name, it will be necessary to publish one, as this form is apparently without a name at the present time.

In the same publication, on page 192, Dr. Bailey has taken up the generic name *Stevensonia* Duncan, giving as the place of publication 'Van Houtte in Fl. des Serr. xv, 177, t. 1595–6 (1865).' I cannot agree with Dr. Bailey that this is publication for the generic name *Stevensonia*. While *Stevensonia Sechellarum* appears in boldface capitals under the figure on the plate, it is followed by 'Hort' in brackets, and *Phoenicophorium Sechellarum* appears at the side in larger type, although italic. In the text, which is the place that really constitutes publication, *Stevensonia grandifolia* Dunc. appears at the top of the page in parentheses, and the real heading, *Phoenicophorium Sechellarum* Herm. Wendl., appears just below it in boldface type twice the size of the type used for *Stevensonia*. And the generic and specific characterizations in Latin are both quoted from H. Wendland (Illust. Hort. **12**: Misc. 5).

On page 194, Dr. Bailey, mentioning the plate 433 appearing in Ill. Hort. in April, 1865, under the name *Phoenicophorium Sechellarum*, and the other plate of the same palm appearing in Flore des Serres in the same month, considers that the former probably antedates the latter since it is

[1] Published by permission of the Secretary of Agriculture.

quoted there, but states that 'it is unsafe to make such a decision, for Van Houtte may have seen an advance proof.' He apparently overlooked the fact that page 5 of the miscellany where the Latin characterization of the genus *Phoenicophorium* and the publication and Latin description of *P. Sechellarum* first appear, is dated février 1865, thus disposing of any doubt as to the date of the first properly published name for this species. If these characterizations written by Hermann Wendland and published in Ill. Hort. in February, 1865, and republished in Flore des Serres in April, 1865, for the generic name *Phoenicophorium*, are to be used in 1930 to validate the horticultural name *Stevensonia*, it will be the second steal in which this poor palm has innocently figured. I am especially interested in the correct name for this palm, as the last citation given by Dr. Bailey, *Phoenicophorium borsigianum* Stuntz, was based on work done by Mr. Stuntz and myself in 1914 on this species, and the name then adopted is now being used by the Department of Agriculture.

Unless Dr. Bailey has reasons more adequate than are evident from examining documents now available to the writer, it would appear that in spite of his great prestige, the recognition which he has given to these names listed in synonymy, *Eugenia paniculata* Banks and *Stevensonia* Dunc., should not be accepted by botanists generally.

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

INDEX TO AMERICAN BOTANICAL LITERATURE

1927–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Aitken, J. B. The Wallabos of British Guiana. Trop. Woods **23:** 1–5. 1 S 1930.

Aldous, A. E. Effect of different clipping treatments on the yield and vigor of prairie grass vegetation. Ecology **11:** 752–759. O 1930.

Allen, R. F. Heterothallism in *Puccinia coronata.* Science II. **72:** 536. 21 N 1930.

Almon, L. Preliminary reports on the flora of Wisconsin. XI. Ranunculaceae—buttercup family. Trans. Wisconsin Acad. Sci. **25:** 205–214. *illust.* 1930.

Ames, L. M. A study of some homothallic and heterothallic Ascomycetes. Mycologia **22:** 318–322. 1 N 1930.

Andrews, A. L. More light upon Holzinger's No. 663. Bryologist **33:** 24–25. "Mr" 21 O 1930.

Andrews, F. M. Algae of Monroe County, Indiana, III. Proc. Indiana Acad Sci. **39:** 57–58. 1930.

Andrews, F. M. A pressure cell. Proc. Indiana Acad. Sci. **39:** 59–61. *f. 1.* 1930.

Andrews, F. M. Studies in pollen. V. Proc. Indiana Acad Sci. **39:** 58–59. 1930.

Arthur, J. M. Light and the green plant. Sci. Monthly **31:** 343–346. O 1930.

Ball, O. M. A partial revision of fossil forms of *Artocarpus.* Bot. Gaz. **90:** 312–325. *f. 1–17.* 17 N 1930.

Barss, A. F. Effect of moisture supply on development of *Pyrus communis.* Bot. Gaz. **90:** 151–176. *f. 1–11.* 23 O 1930.

Barss, H. P. Eastern filbert blight. *Cryptosporella anomala.* (Pk.) Sacc. Month. Bull. Dep. Agr. California **19:** 489–490. *f. 109.* Jl 1930.

Bartram, E. B. *Pottia Fosbergii,* sp. nov. Bryologist **33:** 18–19. *pl. 2.* "Mr" 21 O 1930.

Baxter, E. A trip to Magdalena Bay. Jour. Cactus & Succ. Soc. Am. **2:** 323–327. *illust.* O 1930.

Bennett, C. W. Diseases of raspberries and blackberries. Ohio Agr. Exp. Sta. Bull. 454: 43–66. *f. 15–31.* Je 1930.

Bennett, C. W. Further observations and experiments on the curl disease of raspberries. Phytopathology **20**: 787–802. *f. 1, 2.* O 1930.

Berger, F. *Echinomastus intertextus.* Desert **2**: 86. *illust.* O 1930.

Berry, E. W. The ancestry of our trees. Sci. Monthly **31**: 260–263. S 1930.

Berry, E. W. A new *Pterophyllum* from the Shinarump conglomerate in Utah. Jour. Washington Acad. Sci. **20**: 458–463. *f. 1–3.* 4 N 1930.

Binkley, A. M. Transmission studies with the new psyllid-yellows disease of solanaceous plants. Proc. Am. Soc. Hort. Sci. **1929**: 248–254. F 1930.

Blake, S. F. The typification of *Scripus capitatus* L. Rhodora **32**: 182–185. 4 S 1930.

Boot, G. A. The status of white pine blister rust in the west. Month. Bull. Dep. Agr. California 19: 510–512. *f. 121–122.* Jl 1930.

Breeze, F. J. A wild flower sanctuary on the Tippecanoe. Proc. Indiana Acad. Sci. **39**: 73. 1930.

Brierley, W. G. Cambial activity in the red raspberry cane in the second season. Proc. Am. Soc. Hort. Sci. **1929**: 278–280. F 1930.

Britton, N. L. *Acnistus arborescens.* Addisonia **15**: 43. *pl. 502.* "S" 25 O 1930.

Britton, N. L. *Anoda acerifolia.* Addisonia **15**: 45. *pl. 503.* "S" 25 O 1930.

Britton, N. L. *Cestrum laurifolium.* Addisonia **15**: 41. *pl. 501.* "S" 25 O 1930.

Britton, N. L. *Corynella paucifolia.* Addisonia **15**: 35–36. *pl. 498.* "S" 25 O 1930.

Britton, N. L. *Jacquemontia subsalina.* Addisonia **15**: 37. *pl. 499.* "S" 25 O 1930.

Britton, N. L. *Mentzelia aspera.* Addisonia **15**: 47. *pl. 504.* "S" 25 O 1930.

Britton, N. L. *Proustia Krugiana.* Addisonia **15**: 39. *pl. 500.* "S" 25 O 1930.

Britton, N. L. *Sabinea florida.* Addisonia **15**: 33–34. *pl. 497.* "S" 25 O 1930.

Britton, N. L. Note on *Consolea corallicola,* Small. Jour. Cactus & Succ. Soc. Am. **2**: 347–348. *illust.* N 1930.

Broadway, W. E. Two West Indian turk's cap cacti. Gard. Chron. **88**: 296. *f. 113.* 11 O 1930.

Brown, B. A. The causes of degeneration of Irish potatoes in Connecticut. Storrs Agr. Exp. Sta. Bull. 160: 327–380. *f. 1–8*. O 1929.

Buchholz, J. T. The Ozark white cedar. Bot. Gaz. **90:** 326–332. *f. 1, 2*. 17 N 1930.

Buller, A. H. R. The biological significance of conjugate nuclei in *Coprinus lagopus* and other Hymenomycetes. Nature **126:** 686–689. *f. 1–7*. 1 N 1930.

Burke, V., & Hohl, N. J. Cross inoculation with *Rhizobium radicicolum*. Soil Sci. **30:** 407–411. N 1930.

Burret, M. Palmae novae Luetzelburgianae. Notizbl. Bot. Gart. Berlin **10:** 1013–1026. 1 Au 1930.

Burret, M. Über *Leopoldinia piassaba* Wallace die Stammpflanze der Pará-Piassave. Notizbl. Bot. Gart. Berlin **10:** 1027–1028. 1 Au 1930.

Campbell, D. H. Some reminiscences of fern collecting. Am. Fern Jour. **20:** 60–77. *pl. 3, 4*. 7 Au 1930.

Capalungan, A. V., & Murphy, H. F. Wilting coefficient studies. Jour. Am. Soc. Agron. **22:** 842—847. O 1930.

Chaney, R. W., & Mason, H. L. A Pleistocene flora from Santa Cruz Island, California. Carnegie Inst. Washington Publ. 415: 1–24. *pl. 1–7*. S 1930.

Christensen, C. The genus *Cyrtomium*. Am. Fern. Jour. **20:** 41–52. 7 Au 1930.

Chrysler, M. A. The origin and development of the vegetation of Sandy Hook. Bull. Torrey Club **57:** 163–176. *pl. 6, 7+f. 1*. "Mr" 19 D 1930.

Chute, H. M. The morphology and anatomy of the achene. Am. Jour. Bot. **17:** 703–723. *pl. 42–44*. "O" 10 N 1930.

Clausen, R. E. Inheritance in *Nicotiana Tabacum* X. Carmine-coral variegation. Cytologia **1:** 358–368. *f. 1–9*. O 1930.

Cleland, R. E., & Oelkers, F. Erblichkeit und Zytologie verschiedener *Oenotheren* und ihrer Kreuzungen. Jahrb. Wiss. Bot. **73:** 1–124. *f. 1–12*. 1930.

[Clute W. N.] How often does a branch bear leaves? Am. Bot. **36:** 199–202. O 1930.

[Clute W. N.] The rest period of plants. Am. Bot. **36:** 192–197. O 1930.

Clute, W. N. The smoke tree. Am. Bot. **36:** 183–184. *illust.* O 1930.

[Clute, W. N.] The structure of plants. Am. Bot. **36:** 202–211. O 1930.

[Clute, W. N.] Water in the plant. Am. Bot. **36:** 211–215. O 1930.

Coffman, F. A., & Wiebe, G. A. Hybrid vigor in oats. Jour. Am. Soc. Agron. **22**: 848–860. O 1930.

Collins, J. L., Hollingshead, L., & Avery, P. Autosyndesis among *Crepis setosa* chromosomes. Nature **126**: 759–760. 15 N 1930.

Craw, J. R. Hydrogen-ion reactions of native Indiana fern soils. Proc. Indiana Acad. Sci. **39**: 111–113. 1930.

Crouch, R. B. Septation of the ascus in *Dothidina*. Mycologia **22**: 316–317. 1 N 1930.

Cupp, E. E. Quantitative studies of miscellaneous series of surface catches of marine diatoms and dinoflagellates taken between Seattle and the Canal Zone from 1924 to 1928. Trans. Am. Micros. Soc. **49**: 238–245. Jl 1930.

Darrow, G. M. Effect of light, temperature, and transpiration on elongation of canes of raspberry and other brambles. Proc. Am. Soc. Hort. Sci. **1929**: 308–311. F 1930.

Darrow, G. M., & Waldo, G. F. Cleaning up strawberry stock infected with rootgall nemas. Phytopathology **20**: 919–920. N 1930.

Darrow, G. M., & Waldo, G. F. Fruit-bud formation in the strawberry in spring in southeastern states. Science II. **72**: 349–350. *f. 1.* 3 O 1930.

Daubenmire, R. F. Some flowering plants collected in Parke County, Indiana. Proc. Indiana Acad. Sci. **39**: 133–134. 1930.

Deam, C. C. Plants new or rare in Indiana. XV. Proc. Indiana Acad. Sci. **39**: 123–125. 1930.

Denny, F. E. Sucrose and starch changes in potatoes treated with chemicals that break the rest period. Am. Jour. Bot. **17**: 806–817. "O" 10 N 1930.

Denny, F. E. The twin-leaf method of studying changes in leaves. Am. Jour. Bot. **17**: 818–841. *f. 1–3.* "O" 10 N 1930.

Dodge, B. O. Inheritance of the albinistic non-conidial characters in interspecific hybrids in *Neurospora*. Mycologia **23**: 1–50. *pl. 1–7.* 2 Ja 1931.

Doolas, G. Z. Local variation of soil acidity in relation to soybean inoculation. Soil Sci. **30**: 273–284. *pl. 1, 2.* O 1930.

Dorsey, M. J. The relation between embryo-sac development and the set of fruit in the apple. Proc. Am. Soc. Hort. Sci. **1929**: 56–61. F 1930.

Drechsler, C. Some new species of *Pythium*. Jour. Washington Acad. Sci. **20**: 398–418. 4 O 1930.

Fifteen new species are described.

Eaton, R. J. *Tripsacum dactyloides* in Massachusetts. Rhodora **32**: 185. 4 S 1930.

Eddy, S. The plankton of Reelfoot Lake, Tennessee. Trans. Am. Micros. Soc. **49**: 246–251. Jl 1930.

Elliott, C. Manual of bacterial pathogens. i–ix. 1–349. Baltimore, Williams & Wilkins Co., 1930.

Erwin, A. T. A systematic study of the peppers (*Capsicum frutescens*, L.) Proc. Am. Soc. Hort. Sci. **1929**: 128–131. F 1930.

Evans, A. W. The *Cladoniae* of Connecticut. Trans. Connecticut Acad. Sci. **30**: 363–510. Je 1930.

Ezekiel, W. N., & Neal, D. C. Report of the cotton-root-rot conference at Temple, Texas. Phytopathology **20**: 889–894. N 1930.

Ezekiel, W. N., Taubenhaus, J. J., & Carlyle, E. C. Soil-reaction effects on *Phymatotrichum* root rot. Phytopathology **20**: 803–815. *f. 1.* O 1930.

Faegri, K. Om de i Norden iakttatte *Amsinckia*-arter en systematisk orientering. Bergen Mus. Arbok **1929**: 3–35. *f. 1–5.* 1929.

Fajardo, T. G. Studies on the properties of the bean-mosaic virus. Phytopathology **20**: 883–888. N 1930

Farwell, O. A. What is *Scirpus capitatus* Linn.? Rhodora **32**: 180–181 4 S 1930.

Fassett, N. C. The plants of some northeastern Wisconsin lakes. Trans. Wisconsin Acad. Sci. **25**: 157–168. *f. 1–6.* 1930.

Fassett, N. C. Preliminary reports on the flora of Wisconsin. V. Coniferales. Trans. Wisconsin Acad. Sci. **25**: 177–182; VI. Pandanales. 183–187; VII. Betulaceae. 190–194; VIII. Aceraceae. 195–197; IX. Elatinaceae. 199–200; X. Haloragidaceae. 201–203. *illust.* 1930.

Faull, A. F. On the resistance of *Neurospora crassa*. Mycologia **22**: 288–303. *f. 1.* 1 N 1930.

Fellows, H. Wheat take-all symptoms compared with injuries caused by cinch bugs. Phytopathology **20**: 907–909. *f. 1, 2.* N 1930.

Fernald, M. L. *Gentiana procera* Holm, forma *laevicalyx*, n.f. Rhodora **32**: 221. 14 O 1930.

Fernald, M. L. The identity of *Alopecurus aequalis*. Rhodora **32**: 221–222. 14 O 1930.

Fitzpatrick, H. M. The lower fungi. Phycomycetes. i–xi, 1–331. *f. 1–112.* New York, Mc Graw-Hill Book Co., 1930.

Frick, G. A. *Euphorbia heptagona*. Jour. Cactus & Succ. Soc. Am. **2**: 335–336. *illust.* O 1930.

Frost, F. H. Specialization in secondary xylem of Dicotyledons. II. Evolution of end wall of vessel segment. Bot. Gaz. **90:** 198–212. *f. 1–16.* 23 O 1930.

Fuller, H. J. Stimulatory effects of ultra-violet radiation upon higher plants. Science II. **72:** 535–536. 21 N 1930.

Fulton, H. R. *Citrus* melanose. Month. Bull. Dep. Agr. California **19:** 494–495. *f. 111.* Jl 1930.

Gardner, M. W., & Mains, E. B. Indiana plant diseases, 1929. Proc. Indiana Acad. Sci. **39:** 85–99. *f. 1–7.* 1930.

Gates, F. C. Aspen association in northern lower Michigan. Bot. Gaz. **90:** 233–259. *f. 1–14.* 17 N 1930.

Gates. F. C. Principal poisonous plants in Kansas. Kansas Agr. Exp. Sta. Tech. Bull. 25: 1–67. *f. 1–64.* Jl 1930.

Gates, H. E. *Machaerocereus gummosus*, *Machaerocereus eruca.* Desert **2:** 83. *illust.* O 1930.

Gates, H. E. Milky Mammillarias of lower California. Desert **2:** 94–95. *illust.* N 1930.

Gillett, C. A. An identification key for trees and shrubs in North Dakota. N. Dakota Agr. Exp. Sta. Ext. Circ. 4: 1–21. *illust.* Mr 1928.

Mimeograph copy.

Gleason, A. H. Report on botanical study in Europe, 1930. Jour. N. Y. Bot. Gard. **31:** 264–266. N 1930.

Goss, R. W. The symptoms of spindle tuber and unmottled curly dwarf of the potato. Nebraska Agr. Exp. Sta. Res. Bull. 47: 1–39. *pl. 1–7.* My 1930.

Graustein, J. E. Evidences of hybridism in *Selaginella.* Bot. Gaz. **90:** 46–74. *f. 1–53.* 23 S 1930.

Graves, A. H. Inwood Park, Manhattan. Torreya **30:** 117–129. *f. 1–3.* O 1930.

Greaves, J. D. The microflora of leached alkali soils: I. Synthetic alkali soil. Soil. Sci. **28:** 341–346. N 1929; II. A leached sodium-chloride soil. Soil Sci. **29:** 79–83. Ja 1930.

Greaves, J. E., & Greaves, J. D. The microflora of leached alkali soil. Bot. Gaz. **90:** 224–230. 23 O 1930.

Griffiths, D. Daffodils. U. S. Dep. Agr. Circ. 122: 1–73. *f. 1–50.* O 1930.

Harding, P. L. Respiration studies of Grimes apples under various controlled temperatures. Proc. Am. Soc. Hort. Sci. **1929:** 319–324. *f. 1.* F 1930.

Harlow, W. M. The formation of chambered pith in the twigs of butternut and black walnut. Jour. Forest. **28:** 739–741. *f. 1–5.* My 1930.

Harris, G. H. The influence of top on root as determined by root respirations of young fruit trees. Proc. Am. Soc. Hort. Sci. **1929**: 329–334. *f. 1, 2.* F 1930.

Harris, J. A., Harrison, G. J., & Pascoe, T. A. Osmotic concentration and water relations in the mistletoes, with special reference to the occurrence of *Phoradendron californicum* on *Covillea tridentata*. Ecology **11**: 687–702. *f. 1, 2.* O 1930.

Heald, F. D. Symptoms and effects of the chestnut tree blight caused by *Endothia parasitica* (Murr.) And. Month. Bull. Dep. Agr. California **19**: 491–493. *f. 110.* Jl 1930.

Heath, H. C. Potash shale as a source of potassium for growing plants. Bot. Gaz. **90**: 121–150. *f. 1–9.* 23 O 1930.

Hein, I. Studies on morphogenesis in *Agaricus* (*Psalliota*) *campestris*. Am. Jour. Bot. **17**: 882–915. *pl. 52–55.* 25 N 1930.

Herrera, A. L. Sur l'imitation des chromosomes avec le silicate de sodium e l'alcool. Protoplasma **11**: 168–174. *f. 1, 2.* S 1930.

Hirt, R. R. *Fomes Everhartii* associated with the production of sterile rimose bodies on *Fagus grandifolia*. Mycologia **22**: 310–311. *pl. 25.* 1 N 1930.

Holmes, F. O. Local and systemic increase of tobacco virus. Am. Jour. Bot. **17**: 789–805. *f. 1, 2.* 'O' 10 N 1930.

Houghton, A. D. The Cactus book. i–xii, 1–147. *illust.* New York, Macmillan Co. 1930.

Howlett, F. S. Further evidence on the relative self-fruitfulness of apple varieties. Proc. Am. Hort. Sci. **1929**: 49–55. F 1930.

Hubert, E. E. Forest pathology. Science II. **72**: 351–356. 10 O 1930.

Huskins, C. L., & LaCour, L. Chromosome number in *Capsicum*. Am. Nat. **64**: 382–384. Jl-Au 1930.

Ivanoff, S. S., & Riker, A. J. Studies on the movement of the crown-gall organism within the stems of tomato plants. Phytopathology **20**: 817–829. *f. 1, 2.* O 1930.

Imai, Y. Is fasciated a frequently mutating character? Bot. Gaz. **90**: 116–118. 23 S 1930.

Jackson, R. T. An exceptionally large *Onoclea sensibilis*. Rhodora **32**: 225–226. 3 N 1930.

Jayne, A. *Camptosorus* as a wall fern. Am. Fern. Jour. **20**: 83. 7 Au 1930.

Johansen, D. A. Fertilization in the Cactaceae. Jour. Cactus & Succ. Soc. Am. **2**: 332. O 1930.

Johansen, D. A. Studies on the morphology of the Onagraceae. I. The megagametophyte of *Hartmannia tetraptera*. Bull.

Torrey Club **56:** 285–298. *pl. 11.* "Je" 2 Au 1929; II. Embryonal manifestations of fasciation in *Clarkia elegans.* Bot. Gaz. **90:** 75–91. *f. 1–52.* 23 S 1930; III. *Taraxia ovata* (Nutt.), Small. Ann. Bot. **45:** 111–124. *pl. 6+f. 1–4.* "Ja" 1931; IV. *Stenosiphon linifolium.* Bull. Torrey Club **57:** 315–326. *pl. 16+f. 1–25.* 20 My 1931.

Johnson, D. E. The relation of the cabbage maggot and other insects to the spread and development of soft rot of Cruciferae. Phytopathology **20:** 857–872. *f. 1.* N 1930.

Johnston, I. M. Studies in the Boraginaceae VIII. I. Observations on the species of *Cordia* and *Tournefortia* known from Brazil, Paraguay, Uruguay and Argentina. Contr. Gray Herb. Harvard Univ. **92:** 1–89; II. Taxonomic notes concerning various Borages. 89–95. 20 O 1930.

Jones, B. *Pinus Thunbergii* on Nantucket. Nat. Hort. Mag. **9:** 181–190. *illust.* O 1930.

Jones, J. E. Some familiar wild flowers. *f. 1–272.* New York, Macmillan Co., 1930.

Jones, J. W. Sterility in rice hybrids. Jour. Am. Soc. Agron. **22:** 861–867. O 1930.

Kanehira, R. True "pau hoi" tree of China a new species. Trop. Woods **23:** 8. 1 S 1930.

Karling, J. S. A preliminary descriptive study of a parasitic monad in cells of American Characeae. Am. Jour. Bot. **17:** 928–937. *pl. 56–58.* 25 N 1930.

Karling, J. S. Studies in the Chytridiales. IV. A further study of *Diplophylctis intestina* (Schenk.) Schroeter. Am. Jour. Bot. **17:** 770–778. *pl. 46–49+f. 1, 2.* "O" 10 N 1930.

Kienholz, R. The wood structure of a "pistol-butted" mountain hemlock. Am. Jour. Bot. **17:** 739–764. *f. 1–11.* "O" 10 N 1930.

King, C. J., & Loomis, H. F. Texas root-rot. Month. Bull. Dep. Agr. California **19:** 501–505. *f. 115–117.* Jl 1930.

Knowlton, C. H. Note on *Aster amethystinus.* Rhodora **32:** 185–186. 4 S 1930.

Knowlton, H. E. Some recent results in sterility studies. Proc. Am. Soc. Hort. Sci. **1929:** 62–64. F 1930.

Kobbé, F. W. *Woodwardia areolata* in the vicinity of New York. Am. Fern Jour. **20:** 80–83. 7 Au 1930.

Koch, M. F. Studies in the anatomy and morphology of the composite flower. I. The corolla. Am. Jour. Bot. **17:** 938–952. *pl. 59, 60.+f. 1–4.* 25 N 1930; II. The corollas of the Heliantheae and Mutisieae. 995–1010. *pl. 61, 62+f. 1–5.* "D 1930" 8 Ja 1931.

Kribs, D. A. Comparative anatomy of the woods of Meliaceae. Am. Jour. Bot. **17:** 724–738. "O" 10 N 1930.

Kurz, H. The relation of pH to plant distribution in nature. Am. Nat. **64:** 314–341. Jl-Au 1930.

Lambert, E. B. Two new diseases of cultivated mushrooms. Phytopathology **20:** 917–919. *f. 1.* N 1930.

Lantz, H. L. Pear breeding: an inheritance study of *Pyrus communis* × *P. ussuriensis* hybrid fruits. Proc. Am. Soc. Hort. Sci. **1929:** 13–19. F 1930.

Larsen, J. A. Forest types of the northern Rocky Mountains and their climatic controls. Ecology **11:** 631–672. *f. 1–13.* O 1930.

Latimer, L. P. The relation of cultural practices to a marked outbreak of cork in Mc Intosh apples in northern New England. Proc. Am. Soc. Hort. Sci. **1929:** 149–150. *f. 1.* F 1930.

Lee, H. J. New parasitic fungi of Montgomery County. Proc. Indiana Acad. Sci. **39:** 135. 1930.

Leonian, L. H. Attempts to induce "mixochimaera" in *Fusarium moniliforme.* Phytopathology **20:** 895–901. *f. 1, 2.* N 1930.

Linder, D. H. Notes on *Tremellogaster surinamensis.* Mycologia **22:** 265–270. *pl. 22, 23* 1 N 1930.

Loeske, L. Note about "Fo epilosa " Bryologist **33:** 22. "Mr" 21 O 1930.

Lombard, L. H. The bearberry. Am. Bot. **36:** 184–186. O 1930.

Looser, G. The ferns of central Chile. Am. Fern Jour. **20:** 52–60. *illust.* 7 Au 1930.

Lounsbury, J. A. Investigations on the nature of *Protoachlya paradoxa* Coker. Trans. Wisconsin Acad. Sci. **25:** 215–225. *f. 1, 2.* 1930.

Lutz, H. J. Effect of cattle grazing on vegetation of a virgin forest in northwestern Pennsylvania. Jour. Agr. Res. **41:** 561–570. *f. 1–3.* 1 O 1930.

Lutz, H. J. A new species of *Cupressinoxylon* (Goeppert) Gotham from the Jurassic of South Dakota. Bot. Gaz. **90:** 92–107. *f. 1–13.* 23 S 1930.

Macbride, J. F. South American Viburnums incorrectly described as new species of *Cornus.* Trop. Woods **24:** 29. 1 D 1930.

Mc Clendon, J. F. Hydrogen ion determination. Am. Nat. **64:** 289–313. *f. 1–3.* Jl-Au 1930.

Mc Clintock, J. A. The longevity of *Phyllosticta solitaria* E. and E. on apple seedlings held in cold storage. Phytopathology **20:** 841–848. *f. 1–3.* O 1930.

Mac Daniels, L. D., & Burrell, A. B. Pollination studies with the Mc Intosh apple in the Champlain Valley fruit district. Proc. Am. Soc. Hort. Sci. **1929**: 65–73. F 1930.

Mac Daniels, L. H., & Heinicke, A. J. To what extent is "spray burn" of apple fruit caused by the freezing of the flowers. Phytopathology **20**: 903–906. *f. 1, 2.* N 1930.

Mc Intosh, A. C. Additions to the flora of the Black Hills of South Dakota. Black Hills Engineer **16**: 160–167. *illust.* Mr. 1928.

Mc Intosh, A. E. S. Pollen shedding in cane. Jour. Imp. Coll. Trop. Agr. **7**: 296–299. N 1930.

Mains, E. B. Host specialization of barley leaf rust, *Puccinia anomala*. Phytopathology **20**: 873–882. *f. 1–3.* N 1930.

Mains, E. B., Vestal, C. M., & Curtis, P. B. Scab of small grains and feeding trouble in Indiana in 1928. Proc. Indiana Acad. Sci. **39**: 101–110. *f+ 1–4.* 1930.

Malhotra, R. C. Can sex ratio be altered in dioecious plants? Am. Nat. **64**: 470–472. S-O 1930.

Malme, G. O. A. N. Einige während der zweiten Regnellschen Reise gesammelte Phanerogamen. Ark. Bot. **23^{4}A**: 1–24. 1930.

Malme, G. O. A. N. Porinae et Phylloporinae in Itinere Regnelliano primo collectae. Ark. Bot. **23^{1}A**: 1–37. 1930.

Manning, J. The Cactacean's primer. Jour. Cactus & Succ. Soc. Am. **2**: 349–352. *illust.* N 1930.

Markgraf, F. Neue Apocynaceen aus Südamerika III. Notizbl. Bot. Gart. Berlin **10**: 1033–1039. *f. 18.* 1 Au 1930.

Martelli, U. Fiji Pandanaceae. Univ. California Publ. Bot. **12**: 325–350. *pl. 37–44.* 23 O 1930.

Martelli, U. A new *Pandanus* from British Borneo. Univ. California Publ. Bot. **12**: 369–372. *pl. 48.* 23 O 1930.

Martelli, U. Pandanaceae of Tonga. Univ. California Publ. Bot. **12**: 351–362. *pl. 45, 46.* 23 O 1930.

Martelli, U *Pandanus odoratissimus* var. *Loureirii* Gaud. Univ. California Publ. Bot. **12**: 373–374. 23 O 1930.

Martelli, U. Two new varieties of *Pandanus odoratissimus* Linn. in the Hawaiian group. Univ. California Publ. Bot. **12**: 363–368. *pl. 47.* 23 O 1930.

Merrill, E. D. Le genre *Talbonia* O. Kuntze synonyme de *Calotis*. Bull. Soc. Bot. France **77**: 340–341. 1930.

Metcalf, H. The Woodgate rust. Month. Bull. Dept. Agr. California **19**: 496–497. Jl 1930.

Milbrath, D. G. A discussion of the reported infections chlorosis of the rose. Month. Bull. Dep. Agr. California **19**: 535–544. *f. 123–127.* Au 1930.

Morgan, W. P. A note on the hydridizing of Freesias. Proc. Indiana Acad. Sci. **39**: 53–55. 1930.

Morton, C. V. A new canon-ball tree from Panama. Jour. Washington Acad. Sci. **20**: 396–398. *f. 1.* 4 O 1930.
Couroupita Cutteri, sp. nov.

Morton, C. V. Two new species of *Meibomia* from Mexico. Bull. Torrey Club **57**: 181–182. "Mr" 19 D 1930.

Moxley, E. A. The hall carpet. Bryologist **33**: 22-24. "Mr" 21 O 1930.

Muenscher, W. C. Some changes in the weed flora of Whatcom County, Washington. Torreya **30**: 130–134. O 1930.

Munger, T. T. Ecological aspects of the transition from old forests to new. Science II. **72**: 327–332. 3 O 1930.

Murneek, A. E. The use of bees in the apple sterility studies. Proc. Am. Soc. Hort. Sci. **1929**: 39–42. *f. 1.* F 1930.

Murrill, W. A. The imperious sycamore. Sci. Am. **143**: 128–129. *illust.* Au 1930.

Nelson E. W. Methods of studying shrubby plants in relation to grazing. Ecology **11**: 764–769. O 1930.

Nichols, S. P. The effect of chloroform upon the rotation in the internodes of *Nitella*. Bull. Torrey Club **57**: 153–162. *pl. 5+f. 9, 10.* "Mr" 19 D 1930.

O'Hanlon, M. E. (Sister). Gametophyte development in *Reboulia hemisphaerica*. Am. Jour. Bot. **17**: 765–769. *pl. 45+f. 1.* "O" 10 N 1930.

Ohashi, H. Cytological study of *Oedogonium*. Bot. Gaz. **90**: 177–197. *pl. 1–3+f. 1–21.* 23 O 1930.

Passmore, S. F. Microsporogenesis in the Cucurbitaceae. Bot. Gaz. **90**: 213–223. *f. 1–40.* 23 O 1930.

Pearson, H. M. The thrips factor in onion sterility. Jour. Econ. Entom. **23**: 829–831. O 1930.

Pearson, O. H. Observations on the type of sterility in *Brassica oleracea* var. *capitata*. Proc. Am. Soc. Hort. Sci. **1929**: 34–38. F 1930.

Pease, A. S. A *Carex* new to New England. Rhodora **32**: 258. 3 N 1930.

Peckham, E. A. S. Beardless *Iris* and *Iris* species. Jour. N. Y. Bot. Gard. **31**: 244–252. O 1930.

Pilger, R. Einige neue Santalaceae aus Südamerika. Notizbl. Bot. Gart. Berlin **10**: 1029–1032. 1 Au 1930.

Pitman, E. M. Treasures of a South Portland (Maine) woodsy area. Bryologist **33**: 17–18. "Mr" 21 O 1930.

Plagge, H. H. A study of soggy breakdown and some related functional diseases of the apple. Proc. Am. Soc. Hort. Sci. **1929**: 315–318. F 1930.

Porter, R. H., Chen, H. K., & Yu, T. F. Smut resistance in millet. Phytopathology **20:** 915–916. N 1930.

Potter, T. I. Uncommon orchids of Trinidad. Orchid Rev. **38:** 309–310. O 1930.

Price, G., & Welsh, W. H. Enumeration of the vascular flora of a limestone area of the Bloomington quadrangle, Monroe County, Indiana. Proc. Indiana Acad. Sci. **39:** 127–131. 1930.

Prouty, W. F. A bituminous fossil plant from the Triassic of North Carolina. Science II. **72:** 527. 21 N 1930.

Ragle, M. E. The structure of the perithecium in the Meliolineae. Mycologia **22:** 312–315. 1 N 1930.

Ranker, E. R. The nature of smut resistance in certain selfed lines of corn as indicated by filtration studies. Jour. Agr. Res. **41:** 613–619. *f. 1–3.* 15 O 1930.

Rasmussen, E. J. The period of blossom bud differentiation in the Baldwin and McIntosh apples. Proc. Am. Soc. Hort. Sci. **1929:** 255–260. *pl. 1, 2+f. 1–6.* F 1930.

Raup, H. M. The distribution and affinities of the vegetation of the Athabasca—Great Slave Lake region. Rhodora **32:** 187–208. *f. 1–8.* 14 O 1930.

Record, S. J. Bibliography of the woods of the world (exclusive of the temperate region of North America) with emphasis on tropical woods. Ed. 2. 1–40. New Haven. 1923; Supplement No. I. 1–10. Ja 1925.

Record, S. J. Check list of British Honduras trees, shrubs and Lianas. 1–64. New Haven, Conn., 1 N 1930.

Record, S. J. Local names of the woody plants of British Honduras. Trop. Woods **24:** 15–28. 1 D 1930.

Record, S. J., & Kuylen, H. Santa Marta Valley, Colombia. Trop. Woods **23:** 9–23. 1 S 1930.

Richter, F. Über die Verbreitungsbedingungen der Kakteen in Mexico. Monats. Deutsch. Kakteen-Gesell. **2:** 191–199. *illust.* S 1930.

Riker, A. J., & others. Studies on infections of hairy root of nursery apple trees. Jour. Agr. Res. **41:** 507–540. *f 1–5,* 1 O 1930.

Roberts, J. W. Apple blotch. Month. Bull. Dept. Agr. California **19:** 498–500. *f. 113–114., illust.* Jl 1930.

Rost, E. C. *Astrophytum myriostigma* or "bishop's cap." Desert **2:** 79–80. *illust.* O 1930.

Ruehle, G. D. *Stemphylium congestum* and its relation to decay in apples. Mycologia **22:** 304–309. *f. 1, 2.* 1 N 1930.

Sampson, H. C. The mixed mesophytic forest community of northeastern Ohio. Ohio Jour. Sci. **30:** 358–367. S 1930.

Sampson, H. C. Succession in the swamp forest formation in northern Ohio. Ohio Jour. Sci. **30**: 340–357. S 1930.

Samuels, M. C. *Echeveria agaroides*. Desert **2**: 98. *illust.* N 1930.

Satina, S., & Blakeslee, A. F. Imperfect sexual reactions in homothallic and heterothallic Mucors. Bot. Gaz. **90**: 299–311. *f. 1–15.* 17 N 1930.

Saunders, C. F. A neglected nut of the desert region. Desert **2**: 91. *illust.* N 1930.

Sax, K. Chromosome counts in *Vitis* and related genera. Proc. Soc. Hort. Sci. **1929**: 32–33. F 1930.

Schaffner, J. H. The ecological determination of twisted hypocotyl and other peculiar expressions in hemp. Am. Nat. **64**: 367–379. Jl-Au 1930.

Schaffner, J. H. Sex reversal and the experimental production of neutral tassels in *Zea Mays*. Bot. Gaz. **90**: 279–298. *f. 1–4.* 17 N 1930.

Seaver, F. J. A rare Phalloid from the New York Botanical Garden. Mycologia **23**: 83–84. *pl. 8.* 2 Ja 1931.

Severin, H. H. P. Carrot and parsley yellows transmitted by the six-spotted leafhopper, *Cicadula sexnotata* (Fall.). Phytopathology **20**: 920–921. *f. 1.* N 1930.

Sewell, M. C., & Gainey, P. L. Interrelation of nutrients and soil reaction on growth and inoculation of alfalfa. Soil Sci. **30**: 297–299. *pl. 1–3.* O 1930.

Small, J. K. Harvesting *Iris* seeds in the Gulf States. Jour. N. Y. Bot. Gard. **31**: 272–277. *f. 1.* N 1930.

Small, J. K. *Iris* studies in the Gulf States. Jour. N. Y. Bot. Gard. **31**: 237–244. *f. 1–4.* O 1930.

Smith, A. C. Notes on Pteridophyta from Mount Roraima. Bull. Torrey Club **57**: 177–180. *pl. 8.* "Mr" 19 D 1930.

Syngramma brevifrons and *Lycopodium Tatei* are described as new species.

Smith, C. O. Pear blight on *Cotoneaster*. Phytopathology **20**: 922. N 1930.

Smith, F. H. The corm and contractile roots of *Brodiaea lactea*. Am. Jour. Bot. **17**: 916–927. *f. 1–18.* 25 N 1930.

Smith, R. C., & Barker, H. D. Observations on the "yellows" disease of beans and related plants in Haiti. Jour. Econ. Entom. **23**: 842–847. *pl. 32.* O 1930.

Standley, P. C. A new *Inga* from British Honduras. Trop. Woods **23**: 7. 1 S 1930.

Stanfield, F. W. Variation in British ferns. Am. Fern Jour. **20**: 78–80. 7 Au 1930.

Stanton, T. R., & others. Influence of hulling the caryopsis on

covered-smut infection and related phenomena in oats. Jour. Agr. Res. **41**: 621–623. 15 O 1930.

Stapf, O. *Leptosaccharum filiforme*, A. Camus. Hooker's Icon. Plant. **2**: *pl. 3125.* Jl 1927.

A South American plant.

Stebbins, G. L., Jr. *Thelypteris fragrans* (L.) Nieuwl. var. *Hookeriana* Fernald on the Maine coast. Am. Fern Jour. **20**: 86–87. 7 Au 1930.

Stevens, F. L. The response to ultra-violet irradiation shown by various races of *Glomerella cingulata*. Am. Jour. Bot. **17**: 870–881. *f. 1–9.* 25 N 1930.

Stevenson, J. A. The downy mildew of the hop. Month. Bull. Dept. Agr. California **19**: 513–515. Jl 1930.

Steward, A. N. The case for *Polygonum cuspidatum* Sieb. & Zucc. Rhodora **32**: 223–225. 3 N 1930.

Stokey, A. G. Prothallia of the Cyatheaceae. Bot. Gaz. **90**: 1–45. *f. 1–186.* 23 S 1930.

Stout, A. B. Botanical observations in Europe. Jour. N. Y. Bot. Gard. **31**: 261–264. N 1930.

Stout, G. L. New fungi found on the Indian corn plant in Illinois. Mycologia **22**: 271–287. *pl. 24.* 1 N 1930.

Phaeocytosporella gen. nov. and fifteen new species in various genera are described.

Strattan, M. S. Two stations for *Aspidium simulatum* in Pennsylvania. Am. Fern Jour. **20**: 84. 7 Au 1930.

Swingle, C. F. Oxyquinoline sulphate as a preservative for plant tissues. Bot. Gaz. **90**: 333–334. 17 N 1930.

Swingle, C. F. Some factors influencing the growth of apple seedlings. Proc. Am. Soc. Hort. Sci. **1929**: 74–76. F 1930.

Taubenhaus, J. J., & Ezekiel, W. N. Studies on the overwintering of *Phymatotrichum* root rot. Phytopathology **20**: 761–785. *f. 1–4.* O 1930.

Test, F. H. Pteridophytes of Turkey Run State Park. Proc. Indiana Acad. Sci. **39**: 115–118. 1930.

Tetrault, P. A. The decomposition of cellulose in nature. Proc. Indiana Acad. Sci. **39**: 137–151. 1930.

Theriot, I. Le genre *Leptodontium* au Chili. Rev. Chilena Hist. Nat. **33**: 515–517. *pl. 28.* 1929.

Thomas, R. C. Composition of fungus hyphae II. *Sclerotinia*. Am. Jour. Bot. **17**: 779–788. "O" 10 N 1930.

Thompson, W. P. Cause of difference in success of reciprocal interspecific crosses. Am. Nat. **64**: 407–421. S-O 1930.

Thurston, H. W., & Kern, F. D. Notes on some rust collections from Colorado, Wyoming, and South Dakota. Mycologia **23**: 77–82. 2 Ja 1931.

Torrey, R. H. Unusual plant occurrences around New York. Jour. N. Y. Bot. Gard. **31**: 267–271. N 1930.

Turrill, W. B. *Beloperone flaviflora*, Turrill. Hookers Icon. Plant. **2**: *pl. 3114* Jl 1927.

A West Indian plant.

Valleau, W. D., & Johnson, E. M. Some possible causes of streak in tomatoes. Phytopathology **20**: 831–839. O 1930.

Van Graan, L. R. The effect of early defoliation of vegetable plants on subsequent growth and production. Proc. Am. Soc. Hort. Sci. **1929**: 109–113. F 1930.

Van Hook, J. M. Indiana Fungi XII. Proc. Indiana Acad. Sci. **39**: 75–83. 1930.

Waite, M. B. The peach yellows group of peach diseases. Month. Bull. Dep. Agr. California **19**: 484–488. *f. 107–108.* Jl. 1930.

Walker, L. B. Studies on *Ascoidea rubescens*. I. History and development. Mycologia **23**: 51–76. *f. 1–74.* 2 Ja 1931.

Wardlaw, C. W. Panama disease research. A discussion of the relation of results obtained to field conditions. Jour. Imp. Coll. Trop. Agr. **7**: 278–281. O 1930.

Weatherby, C. A. Distinguishing *Woodsia* and *Cystopteris*. Am. Fern Jour. **20**: 85–86. 7 Au 1930.

Webber, J. M. Chromosome number and morphology in *Nicotiana*. V. The character of tetraploid areas in chromosomal chimeras of *N. sylvestris* Speg. and Comes. Univ. California Publ. Bot. **11**: 355–366. *pl. 16, 17+f. 1–3.* 29 O 1930.

Webber, J. M. Interspecific hybridization in *Nicotiana*. XI. The cytology of a sesquidiploid hybrid between *Tabacum* and *sylvestris*. Univ. California Publ. Bot. **11**: 319–354. *pl. 10–15+f. 1–11.* 31 O 1930.

Welch, W. H. Forest and prairie, Benton County, Indiana. Proc. Indiana Acad. Sci. **39**: 67–72. *f. 1.* 1930.

Wentworth, S. W. Further evidence of the variability of apple pollen as determined by the spur-unit method. Proc. Am. Soc. Hort. Sci. **1929**: 43–48. F 1930.

Werdermann, E. *Echinocactus Schwebsianus* Werd. n.sp. Monats. Deutsch. Kakteen-Gesell. **2**: 186–189. *illust.* S 1930.

A plant from Bolivia.

West, J. The genus *Rosularia*. Jour. Cactus & Succ. Soc. Am. **2**: 356–357. *illust.* N 1930.

White, P. R. A disease and evolution. Sci. Monthly **31**: 306–318. *illust.* O 1930.

Wieland, G. R. Conifer inflorescence. Science II. **72**: 113–115. 1 Au 1930.

Williams, R. S. Mosses collected in Brazil and Argentina by J. N. Rose in 1915. Jour. Washington. Acad. Sci. **20**: 465–475. *f. 1–13.* 19 N 1930.

Includes description of *Microthamnium Russellii*, sp. nov. and of two new combinations.

Williams, R. S. *Pseudoleskea Arizonae*, sp. nov. Bryologist **33**: 20. *pl. 3.* "Mr" O 1930.

Wilson, L. R. Preliminary reports on the flora of Wisconsin. IV. Lycopodiaceae, Selaginellaceae. Trans. Wisconsin Acad. Sci. **25**: 169–173. 1930.

Woodworth, R. H. Cytological studies on the Betulaceae IV. *Betula*, *Carpinus*, *Ostrya*, *Ostryopsis*. Bot. Gaz. **90**: 108–115. *f. 1–34.* 23 S 1930.

Woodworth, R. H. Meiosis of microsporogenesis in the Juglandaceae. Am. Jour. Bot. **17**: 863–869. *pl. 50, 51.* 25 N 1930.

Wright, J. G. The pit-closing membrane in the wood of the lower Gymnosperms III. Trans. Royal Soc. Canada **22**: 63–94. *pl. 1, 2.* 1928.

Wright, W. H., Hendrickson, A. A., & Riker, A. J. Studies on the progeny of single-cell isolations from the hairy-root and crown-gall organisms. Jour. Agr. Res. **41**: 541–547. *f. 1.* 1 O 1930.

Wylie, R. B. Cicatrization of foliage leaves I. Wound responses of certain mesophytic leaves. Bot. Gaz. **90**: 260–278. *f. 1–14.* 17 N 1930.

Young, E. M. Physiological studies in relation to the taxonomy of *Monascus* spp. Trans. Wisconsin Acad. Sci. **25**: 227–244. *pl. 1, 2.* 1930.

Yuncker, T. G. Observations on the dwarf mistletoe, *Arceuthobium pusillum*. Proc. Indiana Acad. Sci. **39**: 63–65. *f. 1–3.* 1930.

Zimmerman, P. W. Oxygen requirements for root growth of cuttings in water. Am. Jour. Bot. **17**: 842–861. *f. 1–8.* "O" 10 N 1930.

The subterranean organs of Helianthus scaberrimus

William S. Cooper and Abraham D. Stoesz

(with two text figures)

The Rough Sunflower (*Helianthus scaberrimus* Ell.) is a widely distributed species of the northern prairies. A score of specimens in the herbarium of the University of Minnesota indicate for it a range bounded as follows: from western Indiana and central Minnesota to northwestern North Dakota and northern Oklahoma. Gray extends its northwestern limits to Saskatchewan, and Britton and Small both make it range southward to Georgia and Texas. In the vicinity of Minneapolis, where this study was made, it is a generally distributed, though rarely abundant, member of the tall bunch-grass community, which occurs in the main upon very sandy soils such as outwash and dune sand. Here it produces slender simple stems 30 to 100 cm. high, which bear one to several showy heads on long naked peduncles. The species was included in a research project, carried out by the junior author, dealing with the subterranean organs of local dune plants. In the investigation of this species, features of such unusual interest came to light that a special study was determined upon, the results of which are presented here.

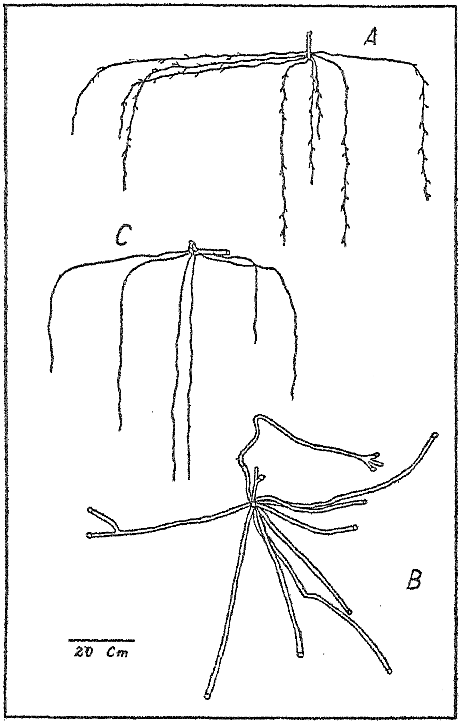


Fig. 1. Subterranean organs of *Helianthus scaberrimus*. *A*. Root system of mature shoot. *B*. Horizontal distribution of rhizomes from mature shoot. *C*. Root system of rhizome-bud in September.

The root system of a mature individual of *Helianthus scaberrimus* consists of a very few main elements, mostly adventitious in origin, simple, thick, white and succulent, with very few and scattered minute rootlets (fig. 1*A*). For the most part they extend horizontally for distances up to a

[The Bulletin for January (58: 1-66) was issued 17 September 1931.]

meter, then turn abruptly downward, commonly reaching a depth of about 80 cm.

During the summer the plant produces from the base of the stem one to several rhizomes, which lie horizontally at a very constant depth of 6 to 8 cm. These are about 3 mm. in diameter. The longest of nearly 500 that were charted measured 102 cm. The greatest number produced by a single plant was 10 (fig. 1*B*). The rhizomes are very similar in appearance to the roots in being normally unbranched, smooth and fleshy, and they have few and inconspicuous nodes.

By September the rhizome is completely developed, and has a single erect, thick, fleshy bud at its tip. Occasionally we find that the terminal bud has met with some disaster, in which case its place is taken by a short bud-tipped branch, or a pair of them, from the next node back. The potential plant at this time is further provided with an independent root system, originating just back of the bud, consisting of several roots exactly like those of the parent except that they are absolutely devoid of rootlets (fig. 1*C*).

The plant is obviously capable of rapid multiplication and extension through its efficient means of propagation. The parent shoot dies at the close of the season, but its place may be taken next year by a group of several, established at quite considerable distances from the parent. The plant seems to be dependent almost entirely upon vegetative reproduction, if the seed, which we collected in hope of making experimental cultures, was a fair sample.

Occasionally the plant extends its sphere of influence in definite systematic order. Most striking was the discovery of a complete circle, a sunflower 'fairy ring,' in an ancient dune area called Bunker Prairie, five miles east of Anoka, Minnesota. Finding it first in the fall of 1927, we immediately determined to chart its limits and follow its development from year to year (fig. 2).

In November, 1927, the 'ring' was almost circular and 11 m. in average diameter. The belt of closely placed plants was 2 to 4 m. wide, and there was thus left an irregular central area, containing very few plants, 4–5 m. across. The outermost individuals were everywhere tall, many of them attaining heights of 60–90 cm.; they were thrifty and had flowered abundantly. Inward from the margin there was evident a progressive decrease in size, thriftiness and flowering, the innermost being sterile shoots 10–20 cm. high, bearing but two or three pairs of leaves.

For more detailed investigation, especially of the subterranean organs, a transect from center to outer margin, two meters wide, was laid out on a north-south line and marked with stakes. Within this area the position

of every sunflower plant was charted. The surface sand was then very carefully removed until the rhizomes were exposed. These also, with the next year's buds, were drawn in upon the chart. The excavation was done a little at a time and the soil carefully replaced, in order that a minimum of

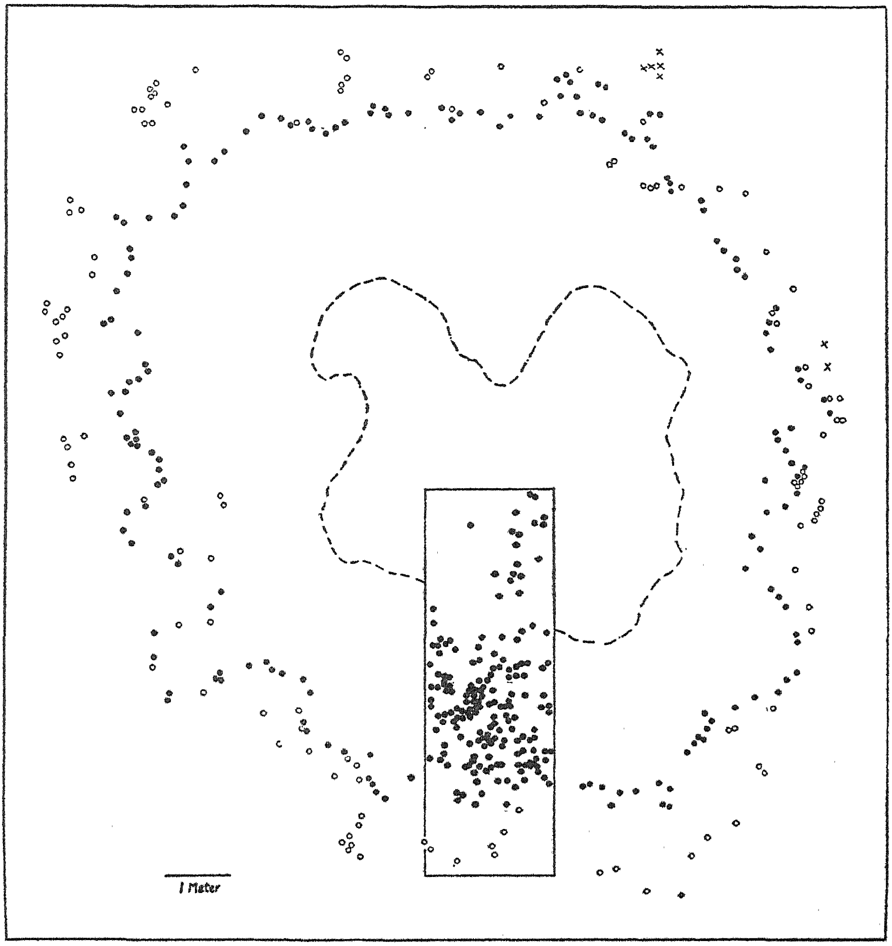


Fig. 2. 'Fairy ring' of *Helianthus scaberrimus*. Dots indicate outermost individuals in 1927, and all individuals of that year within transect; broken line marks inner boundary of thickly populated zone. Circles indicate outermost individuals in 1928; crosses, in 1929.

harm might be done to the buds. It was found that the outer strip characterized by tall plants was .6 m. wide; in this the average height was 55.7 cm. and the maximum 90 cm. In the remainder of the thickly populated belt (2.2 m. wide) the plants were more closely placed, but the average

height was but 23 cm. In that portion of the transect included in the sparsely inhabited central region the average height was 12.7 cm. The rhizomes made a dense tangle at the very constant depth at which they occurred. Two hundred and sixty-eight rhizomes had been produced by 173 parent shoots, an average of 1.55 per plant. In the densely populated zone almost every rhizome was traced to its parent; in the central region many healthy buds had become isolated by the rotting away of the connecting structure. The most striking feature was the outward direction of growth taken by a large majority of the rhizomes. In the thickly populated area, of the total of 192, 82.8 per cent pointed in directions southerly in relation to an east-west line through the parent, and 50 per cent lay within the south quadrant. In the central area this tendency was absent.

In September, 1928, the locality was revisited. The ring was found to be still perfect. Its margin had advanced at practically every point, the distance gained varying from a few centimeters to a meter and a quarter. The outermost plants were again the tallest, and the area occupied in 1927 by tall thrifty shoots was now inhabited by low, mostly non-flowering individuals.

Examination of the transect showed that of 245 buds formed the year before, 146 had survived and produced shoots. The mortality was thus considerable; a part of it was doubtless due to the excavation of the previous fall. A few thrifty flowering individuals grew in the sparsely settled central area, and most of these could be identified with buds of the previous year. Excavation revealed, in the thickly populated zone, a tangle of rhizomes even denser than that of the year before. The 146 shoots of the season had produced 350 new rhizomes, an average of 2.4 per plant. The predicated advance of the margin for the coming year was about one meter. The outward tendency in orientation of the rhizomes was confined almost entirely to the marginal belt newly occupied during the season of 1928.

Upon visiting the locality in September, 1929, we were astonished to find that the 'ring' had vanished. A few scattered plants remained, and two small groups occurred along the line where the advancing margin should have been. In the area of the transect, 8 scattered shoots, producing 11 rhizomes, were the only survivors of the 314 buds charted the year before.

This remarkable 'fairy ring' evidently originated from a single individual, or possibly from a very close group. Its age, assuming an annual advance of one meter, was six or seven years in 1928. Its symmetrical development was helped by the easy penetrability and uniformity of the sandy soil and the fewness of competing plants. The strong preponderance

of outward direction in the rhizomes may be due merely to a tendency to maintain the growth direction of the parent rhizome, traced back to the radially arranged rhizomes of the original parent. This is supported by the fact that in the area of the transect, in both years, the fewest rhizomes lay in the north quadrant, which faces the center of the ring. The absence of a dominating outward tendency in the central region may well be due to reinvasion by the inward-pointing minority.

It has been noted that each year the shoots at the advancing margin were tall and thrifty, that those growing in the region recently occupied were depauperate and non-flowering, and that the center was practically bare.[1] The presence of thrifty individuals in the central area in 1928 would seem to indicate amelioration, after a few years, of the unfavorable conditions associated with the presence of the sunflowers.

One possible cause of this phenomenon is less severe competition for soil water at the outer margin, where the plants are less closely spaced and entirely free on one side, in contrast to the crowded condition in the thickly populated zone just behind. Considering the ease of capillary water movement in the sandy soil, this explanation does not seem adequate. There remains the possibility of a chemical modification due to the plants—the abstraction or the addition of some substance. An attempt was made to solve the problem through greenhouse cultures in soils taken from outside the ring, zone of luxuriant growth, zone of depauperate growth, and center. Since we failed to find any viable seed of *Helianthus scaberrimus*, the common sunflower was substituted, and we also used wheat. Average height, green and dry weight were measured. The results were not sufficiently illuminating to justify full presentation here. One or two statements will be sufficient. Growing in soils gathered in 1927, sunflower and wheat cultures showed very satisfactory agreement. Using the cultures from the soil outside the ring as the standard, those growing in soil from the zone of tall sunflowers and from the center showed a great reduction in size, while those growing in soil from the zone of depauperate plants showed a marked increase over the controls. We thus have, in the main, an inverse correlation. Similar cultures in soils gathered in 1928 gave totally inconsistent results. These experiments would seem to point toward a chemical factor as the cause, but farther than that we cannot go.

The production of so perfect a ring as the one we have described is of course a rare occurrence, depending on the combined presence of a number of favorable factors. For the most part the species occurs as scattered indi-

[1] Dr. F. K. Butters, of this Department, states that the case is similar with an unidentified garden species of *Helianthus*, which absolutely requires new soil in order to produce satisfactory shoots and flowers.

viduals, which are in a state of constant migration. Each spring the developing bud finds itself in an area of fresh soil, with a fully developed root system ready for operation. In spite of the high mortality to which it is subject, it thus maintains itself as a constant and characteristic member of the prairie community.

University of Minnesota
Minneapolis
and
North Dakota Agricultural College
Fargo

The relationships of certain myrmecophilous melastomes

H. A. Gleason

Myrmecophily, as evinced by the presence of hollow organs known as formicaria produced on some part of the leaves, has been developed among various genera of the Melastomataceae. These organs are usually inhabited by small biting ants and the plants are carefully avoided by the natives. Whether or not the presence of the ants is of any benefit or even of any significance to the plant is still open to question; perhaps the prevailing opinion is that it is not.[1] The existence of these structures has regularly been considered of taxonomic importance, and Cogniaux, in his monograph of the family, separated four genera on this feature alone, *Tococa, Microphysca*, *Myrmidone*, and *Maieta*. The present paper deals with the latter one alone.

Of these four, *Tococa* has a terminal inflorescence; *Microphysca* has a winged hypanthium; and *Myrmidone* is characterized by few and large seeds. In *Maieta* the inflorescence is axillary, the hypanthium not winged, and the seeds numerous and minute. Its species range in size from low shrubs to small but slender trees. Since they commence to flower at an early age, collections are usually made from the smaller plants where the flowers are more easily observed, and field notes generally indicate them as shrubs one to two meters high.

In the latest general treatment of the family (Monog. Phaner. **7**: 975–979. 1891) Cogniaux recognized eight species and one variety. The discovery of these plants had progressed during more than a century of botanical exploration in tropical America and the dates when each was first described are as follows:

1. *Maieta guianensis* Aubl. 1775.
2. *M. heterophylla* (Desr.) DC. 1796.
3. *M. Poeppigii* Mart. 1823.
4. *M. tococoidea* (DC.) Cogn. 1828.
5. *M. vesiculosa* (DC.) Cogn. 1828.
6. *M. setosa* (Triana) Cogn. 1867.
7. *M. dentata* (Triana) Cogn. 1871.
8. *M. testiculata* (Triana) Cogn. 1871.
9. *M. tococoidea* var. *Watsonii* Cogn. 1891.

All of these passed through various changes of names or received some synonyms before they were finally brought together in one genus by Cogni-

[1] For a recent study of myrmecophily in the related genus *Tococa*, with an excellent general discussion and bibliography, see Douglas Melin, Contributions to the study of the theory of selection I. Zool. Bidr. Uppsala **13**: 87–104. *f. 1–3*. 1930.

aux, except the third, which was not actually given a name until 1871, and the last. These are specified in detail under each species in the taxonomic treatment below.

Since 1891 the botanical exploration of tropical America has proceeded rapidly and other species have been added to the genus:

10. *M. juruensis* Pilger. 1905.
11. *M. guianensis* var. *peruviana* (Cogn.) Ule. 1908.
12. *M. robusta* Rusby. 1920.
13. *M. glandulifera* Standley. 1924.
14. *M. hispida* Rusby. 1927.
15. *M. cuneata* Standley. 1930.

While *Maieta*, as recognized by Cogniaux, has a botanical history extending back almost to Linnaean times, it has not always included all the species assigned to it by Cogniaux. For more than half a century it was a competitor with De Candolle's genus *Calophysa*, which indeed came to be much the larger of the two, until the latter was finally suppressed by Cogniaux. Our next tasks are therefore to determine whether all the species at present described under *Maieta*, in the sense of Cogniaux, are rightfully of that genus, and then to discuss the wisdom of the merging of *Maieta* with *Calophysa*, after these two genera had been considered distinct by such eminent students of the family as De Candolle, Naudin, and Triana.

The following species are to be reduced, excluded, or transferred to another genus.

5. MAIETA VESICULOSA (DC.) Cogn. Fl. Bras. **14**[4]: 463. 1888. *Tococa vesiculosa* DC. Prodr. **3**: 166. 1828. *Calophysa vesiculosa* Triana, Trans. Linn. Soc. Bot. **28**: 140. 1871.

The species was founded by the author on an illustration of a Mexican plant by Moçino and Sessé and was regarded by him originally as a more or less doubtful species. Dr. John H. Barnhart supplies the information that the plates of which this was one were the property of the Spanish government and on loan to De Candolle. Their return being peremptorily demanded, De Candolle secured the voluntary assistance of a number of ladies of Geneva, who made copies of them; reproductions of these copies were afterward published. De Candolle's brief description of the species is apparently taken from the copy, or at least agrees well with it. Whether the copy is a faithful duplicate of the original, or whether the original accurately represents the plant, is at present unknown. The plant distinctly shows a 5-merous flower, which alone is enough to distinguish it from *M. setosa*, in addition to the other points mentioned by Triana (loc. cit.). It is probable that the plate represents a *Tococa*, possibly like *T. Peckiana* Robinson.[2]

9. MAIETA TOCOCOIDEA (DC.) Cogn. var. WATSONII Cogn. Monog. Phaner. **7**: 979. 1891. The Central American specimens of this species, upon which the varietal name was based, differ only in small particulars from the type and in my opinion do not require special designation.

11. MAIETA GUIANENSIS Aubl. var. PERUVIANA (Cogn.) Ule, Notizbl. **6**: 368. 1915. (*Myrmidone peruviana* Cogn. Engl. Jahrb. **42**: 147. 1908.) The variety is distinguished by unimportant characters and does not deserve even varietal status.

12. MAIETA ROBUSTA Rusby, Descr. S. Am. Pl. 72. 1920. Examination of the type in the herbarium of the New York Botanical Garden shows that it is *Tococa macrophysca* Spruce.

13. MAIETA GLANDULIFERA Standley, Proc. Biol. Soc. Wash. **37**: 52. 1924. Examination of the type in the National Herbarium shows that it is of the genus *Tococa* and possibly close to *T. Peckiana* Robinson.

14. MAIETA HISPIDA Rusby, Mem. N. Y. Bot. Gard. **7**: 315. 1927. The type specimen, in the herbarium of the New York Botanical Garden, is clearly *Maieta guianensis* Aubl.

15. MAIETA CUNEATA Standley, Field Mus. Bot. Ser. **8**: 30. 1930. The type, in the herbarium of the Field Museum, has a densely hirsute stem somewhat suggestive of *M. setosa* (Triana) Cogn. The short petioles and general contour of the leaf give it the aspect of a *Henriettea*, but the petals are acute and inflexed at the tip, with an erect dorsal spur, while the anthers are stoutly oblong, not at all tapering to the tip, and distinctly suggesting *Henriettella* in their structure. There seems to be no reason for assigning the plant to *Maieta* except the presence of axillary flowers and formicaria. The former are found in a number of genera in the same tribe of the family and formicaria are known not only from *Maieta* and its immediate relatives, but also from *Tococa* and *Ossaea*. I accordingly give this plant the name **Henriettella cuneata** (Standl.).

The genus *Maieta*, as understood by Cogniaux, is therefore left with eight species, to which I shall below add three others.

Calophysa, as originally established by De Candolle, was characterized by 4-merous flowers, in contrast to the 5-merous flowers of *Maieta*. The original species had formicaria and this was probably also of some weight in leading the author to its differentiation. Since so many genera of melastomes have both 4-merous and 5-merous flowers, as *Tibouchina*, *Miconia*, and *Clidemia*, we can scarcely consider this feature of generic importance. Naudin discovered a point of greater significance, the anthers of *Maieta*

---

[2] *Tonduz 9397*, from Talamanca, Costa Rica (probably now in Panama) was identified as this species by John Donnell Smith. The specimen in his collection, now in the National Herbarium, is sterile, but is clearly a *Tococa*.

being bifurcate at base; he also mentions that the base of the hypanthium in *Calophysa* becomes swollen at maturity below the comparatively narrow neck, and that the stigma is punctiform rather than peltate. Triana extended the scope of the genus considerably. He admitted that it is difficult to characterize and that some of its species resemble *Clidemia*, although their oblong calyx and general habit suggest an affinity with *Maieta*. The presence of formicaria was not a decisive feature with Triana: of his ten species four were without them and these four were later transferred by Cogniaux to *Clidemia*.

Since the careful studies of staminal structure in this family have shown that these organs are generally the best index to generic relations, it will be advisable to see if such characters may be found to separate the two genera. In *Maieta guianensis*, which typifies the genus, the anthers are rather abruptly bent near the middle and above the bend flattened tangentially to a broadly rounded summit which bears the pore on the dorsal side; toward their base the filament leaves the connective with a curve away from the dorsal side, and the thecae are distinctly prolonged below this point into two basal spurs. These projections must be distinguished from appendages on the connective itself, which are not found in *Maieta* but are characteristic of many other genera in the family. In *Calophysa*, as defined by Triana, the anthers taper to a fairly acute tip and bear the small pore exactly on the end or somewhat toward the ventral side; they are not bifurcate or appendaged in any way at the base, the connective and thecae ending at the insertion of the filament, or the former is somewhat continued as a depressed-conic prolongation to the summit of the filament. This distinction, first shown by Naudin, seems to be of some importance. In *M. guianensis*, also, the anther-sacs are extraordinarily convoluted, the walls on both lateral surfaces of each sac being alternately inflexed almost to the opposite side, while in *Calophysa* they are entire or merely crenulate, in the latter case suggesting that the growth of the thecae has been somewhat greater than that of the connective. Searching for further characters, we find that the flowers of *M. guianensis* are subtended by a calyculus of broad bracts, which are absent in *Calophysa;* the style of the former is very stout with a broadly peltate stigma, of the latter filiform with a capitate or truncate stigma; the flowers of the former are 5-merous, of the latter (with some exceptions) 4-merous; the formicaria of the first are epiphyllous, of the latter usually petiolar. For these reasons it seems advisable to remove from *Maieta* those species placed by Triana in *Calophysa* and the one accepted species described more recently, leaving the genus *Maieta* for *M. guianensis*, its type, and a single other closely related species.

No one can fail to be impressed, as was Triana, with the striking sim-

ilarity in habit between *Calophysa* and certain species of *Clidemia*. *Clidemia ciliata* Don and *Maieta testiculata* Cogn. (*Calophysa testiculata* Triana) are in fact so similar that they may easily be mistaken one for the other, if the obscure formicaria of the latter are not observed, and the chief difference, without dissection, is the stellate pubescence on the lower side of the leaves in the former and the pilose pubescence of the latter. The anthers of the two are strikingly similar.

I accordingly agree with Triana in uniting in the same genus certain species now placed partly in *Maieta* and partly in *Clidemia*, and with Cogniaux in believing that *Calophysa* can not be maintained as an independent genus. Ten of the twelve species named below are accordingly placed in *Clidemia*. The presence of dimorphic leaves in some of them can not be urged as an objection, since *Clidemia dispar*, *C. flexuosa*, and several others exhibit them.

In the taxonomic treatment below, the location of cited specimens in herbaria is designated by initials only:

Botanisches Museum, Berlin (B)
Conservatoire Botanique, Geneva (C)
Field Museum, Chicago (F)
Gray Herbarium, Cambridge (G)
Royal Botanic Gardens, Kew (K)
National Herbarium, Washington (N)
New York Botanical Garden (Y)

I am grateful to the administrative officers of each of these institutions for the opportunity to examine the material under their charge, either by loan or in residence.

Anthers bifurcate at base, the thecae greatly convolute; flowers or inflorescence subtended by ovate to lanceolate bracts; style very stout, 1–1.3 mm. in diameter, the stigma broadly peltate; formicaria wholly epiphyllous. . . . . *Maieta* Aubl.

Anthers simple at base, the thecae entire or crenulate; bracts setaceous; style slender, generally less than 0.5 mm. in diameter, the stigma capitate or truncate; formicaria mostly petiolar. . . . . *Clidemia* Don (in part).

MAIETA Aubl. Pl. Guian. 1: 443. 1775

Shrubs or small trees with strongly dimorphic leaves, the larger member of each pair bearing a formicarium; flowers solitary and sessile to few and short-peduncled, in the axils of the leaves; stem and foliage hirsute or pilose. Flowers 5-merous; hypanthium obconic to campanulate, glandular-hirsute; sepals semicircular, with erect, subulate or slenderly conic exterior teeth; petals obovate, obscurely and broadly clawed; stamens isomorphic; ovary half-inferior, the conic summit setose at the tip.

Flowers 1–3; peduncle and pedicel none and each flower closely subtended by 4 broadly ovate, more or less setose bracts; petiole hirsute or somewhat tomentose above ....1. *M. guianensis.*

Flowers few and peduncled, each pair of ovate or lanceolate, stellate-pubescent bracts distinctly separate from the others; petiole densely tomentose in a narrow strip on the dorsal side..2. *M. Poeppigii.*

1. MAIETA GUIANENSIS Aubl. Pl. Guian. **1:** 443. 1775

Melastoma maieta Desr. Lam. Encyc. **4:** 34. 1796.
Tococa Mayeta Don, Mem. Wern. Soc. **4:** 305. 1823.
Maieta hypophysca DC. Prodr. **3:** 166. 1828.
Majeta dispar Miq. Linnaea **18:** 277. 1844.
Myrmidone peruviana Cogn. Engl. Jahrb. **42:** 147. 1908.
Maieta guianensis Aubl. var. *peruviana* (Cogn.) Ule, Notizbl. **6:** 368. 1915.
Maieta hispida Rusby, Mem. N. Y. Bot. Gard. **7:** 315. 1927.

Common and widely distributed through the Amazonian lowlands and adjacent regions from French Guiana to Bolivia and southeastern Colombia; also in Trinidad (*fide* Cogniaux) and along the shore of Venezuela at least as far west as Caracas.

FRENCH GUIANA—Maroni: *Melinon 162* (F, K, N), *291* (F, N), *291 bis* (F), in 1862 (Y), in 1864 (F, K, N, Y). Acarouany: *Sagot* in 1854 (Y). Godebert: *Wachenheim 130* (K, N). Without locality: *Poiteau* (B, K); *Sagot 235* (K).

BRITISH GUIANA—Potaro River: *Jenman 1283* (K). Kotinang River: *Altson 465* (K). Without data (Y).

SURINAM—Without locality: *Splitgerber* (K).

VENEZUELA—Caracas: *Lockhart* (K).

COLOMBIA—Río Ortaguaza, terr. Caquetá: *Woronow & Juzepczuk 6150* (Y).

BRAZIL—Near Belem, Pará: *Becquaert "Tococa no. 8"* (G), *Becquaert* without number (G). Cultivated at Rio Janeiro: *Glaziou 9818* (K). Near Manáos: *Gwynne Vaughan 7b* (K). Near Taruma: *Traill 309* (or *304*) (G, K). Fonteboa: *Traill 308* (K). Fortaleza, Rio Jurua: *Ule 5913* (B, K). Jurua Miry: *Ule 5550* (B). São Gabriel: *Spruce 2163* (B, G, K). Near Barra on the upper Rio Negro: *Spruce 2163* (Y), *Spruce* without number (K).

PERU—Serra de Escabo: *Ule 20p* (B). Dept. Loreto, Balsapuerto: *Killip & Smith 28407* (Y); Caballo-cocha: *Williams 2351* (Y); above Iquitos: *Tessmann 4561* (B); La Victoria: *Williams 2563* (Y), *2718* (Y); Mishuyacu: *Killip & Smith 29983* (Y); Pebas: *Williams 1623* (Y); San Antonio: *Killip & Smith 29509* (Y); Soledad: *Killip & Smith 29760* (Y); Tierra Doble: *Williams 1069* (Y); Timbuchi: *Williams 947* (Y). Dept. Junín, Cahuapanas: *Killip & Smith 26779* (Y); Puerto Bermudez: *Killip & Smith 26544* (Y), *26551* (Y); Santa Rosa, Pichis Trail: *Killip & Smith 26151* (Y). Dept. San Martín, Mount Guayrapurima; without other data, probably Spruce (K); Tarapoto: without data, probably Spruce (K).

BOLIVIA—Tumapasa: *White 1839* (Y).

2. Maieta Poeppigii Mart. ex Triana, Trans. Linn. Soc. Bot. 28: 141. 1871

Tococa Mayeta Don, Mem. Wern. Soc. 4: 305. 1823, *in part*.

The species closely resembles the preceding, but may usually be distinguished by its broader, more abruptly acuminate large leaves and its subrotund small leaves, as well as by the more accurate characters stated in the key. The specimens from Cocos Island more closely resemble *M. guianensis* in foliage and have shorter peduncles than the type, but do not appear to be distinct.

British Guiana—Kangaruma: *Gleason 182* (K, N, Y). Rockstone: *Gleason 686* (N, Y).

Brazil—Rio Pará: *Poeppig* without number, probably type collection (B). Puritizal: *Ule 5667* (B). Jurua Miry: *Ule 5449* (B, K).

Peru—Amazon River: *Poeppig 3025* (B). Pueblo Nuevo: *Ruiz* (B). Dept. Loreto, La Victoria: *Williams 2545* (Y), *2717* (Y); Manfinfa: *Williams 1169* (Y); Pebas: *Williams 1571* (Y), *1689* (Y); Santa Ana: *Williams 1239* (Y). Dept. Junín, Puerto Bermudez: *Killip & Smith 26432* (Y).

Costa Rica—Cocos Island: *Pittier 12374* (G, N), *16225* (B, G); *Svenson 401* (Y).

Clidemia Don, Mem. Wern. Soc. 4: 306. 1823

The description and key apply to the myrmecophilous species only. About a hundred other species, of diverse structure and habit, occur in tropical America and constitute a polymorphic group which may eventually need segregation or division among other genera.

Shrubs or small trees with isomorphic or somewhat dimorphic leaves, the larger or both bearing a formicarium in most cases; flowers in peduncled clusters from the axils of the leaves; stem and foliage more or less hirsute or pilose. Flowers 5-merous (with one exception); hypanthium tubular or somewhat cylindric, often ampliate at the base, glabrous or hirsuite; sepals with stout, erect or spreading exterior teeth; petals obovate-oblong, mostly retuse; stamens isomorphic; ovary half to wholly inferior.

Formicaria pendent on the stem at the base of the petiole; leaves broadly cordate-ovate, 7–9-nerved, serrulate, short-acuminate, freely pubescent on both sides; flowers 4-merous; hypanthium narrowly campanulate; exterior calyx-teeth suberect or nearly horizontal; petals less than 3 mm. long; connective not prolonged at base; ovary 4-celled.

Leaves cordate-clasping, nearly or quite sessile; hypanthium freely setose.

Pubescence of the lower leaf-surface of simple bristles.........1. *C. testiculata*.

Pubescence of the lower leaf-surface and stem wholly or chiefly of stellate hairs ....2. *C. ciliata*.

Leaves with petioles 3–8 cm. long; hypanthium minutely pubescent, usually not setose..3. *C. tococoidea*.

Formicaria at the summit of the petiole or on the blade; connective often shortly prolonged at base.

Free petiole below the formicarium much longer than the formicarium itself, usually 2–8 cm. long; leaves rounded to cordate at base, nearly or quite isomorphic; stem, petiole, and inflorescence densely setose with stiff, slender, yellowish, reflexed or spreading bristles 8–15 mm. long; flowers 4–5-merous; hypanthium nearly or quite glabrous; calyx-tube setose; flowers in long-peduncled, freely branched clusters.

Formicaria wholly petiolar; leaves oval or broadly elliptic, more than half as wide as long, 7–9-nerved; pubescence beneath the setae of the stem, petioles, and inflorescence essentially none; flowers 4-merous .... 4. *C. setosa.*

Formicaria mostly or wholly epiphyllous; leaves pli-nerved; petioles and inflorescence distinctly pubescent beneath the setae; leaves pubescent on the veins beneath.

Formicaria mostly on the blade; leaves elliptic-oblong, less than half as wide as long, 5-pli-nerved, flat; calyx-tube sparsely short-setose; flowers 4-merous .... 5 *C. pubescens*

Formicaria wholly epiphyllous; leaves broadly elliptic, more than half as wide as long, 7-pli-nerved, heavily bullate; calyx-tube setose with hairs 8–9 mm. long; flowers 5-merous .... 6. *C. spectabilis.*

Free petiole below the formicarium short or none and always shorter than the formicarium itself; leaves cordate or acuminate at base, isomorphic or dimorphic; stem hirsute with much shorter and spreading bristles; flowers 4–5-merous in dense or freely branched clusters; hypanthium and calyx-tube hirsute or merely stellate.

Leaves isomorphic, obovate, distinctly cuneate at base above the petiolar formicarium; flowers 5-merous; hypanthium densely hirsute with simple and glandular hairs; exterior calyx-teeth erect; ovary 3-celled, half-inferior, the free summit densely setose.................................. 7. *C. juruensis.*

Leaves strongly dimorphic, the larger inequilateral at the rounded base, 5–7-pli-nerved; formicaria partly epiphyllous; flowers 5-merous; exterior calyx-teeth erect, sparsely setose; hypanthium minutely stellate, not setose. .8. *C. foliosa.*

Leaves strongly dimorphic, cordate at base, narrowly oblong-elliptic, 3–5-nerved; formicaria wholly petiolar; flowers 4–5-merous; exterior calyx-teeth spreading horizontally; ovary nearly or wholly inferior, tipped with a short beak.

Flowers 5-merous; ovary 5-celled; hypanthium and exterior calyx-teeth glandular-hirsute................................... 9. *C. heterophylla.*

Flowers 4-merous; ovary 4-celled; hypanthium and exterior calyx-teeth thinly and minutely stellate.................................. 10. *C. Sprucei.*

1. **Clidemia testiculata** (Triana) comb. nov.

Calophysa testiculata Triana, Trans. Linn. Soc. Bot. **28**: 140. 1871.
Maieta testiculata Cogn. Fl. Bras. **14**[4]: 463. 1888.

The formicaria are small and often hidden by the bases of the sessile leaves, or may be absent completely, as in *Killip & Smith 15086*. The type is *Triana 3938*, of which I have examined two specimens; it differs in no essential features from the other sheets cited.

VENEZUELA—Merida: *Moritz 945* (B, K, N, Y); *Pittier 12744* (Y), *12806* (Y).

COLOMBIA—Buena Vista, near Ocaña: *Ariste-Joseph* (N). Dept. Cundimarca, Susumuco, near Bogota: *Triana 3938* (C, K). Dept. El Valle, Pavas: *Pennell 5518* (Y). Dept. Santander, Mesa de los Santos: *Killip & Smith 15086* (Y).

PERU—Dept. Junín, Dos de Mayo: *Killip & Smith 25798* (Y).

COSTA RICA—Canas Gordas: *Pittier 10960* (F, N); Llanuras de Santa Clara: *Smith 6562* (F, G, K, N); without locality: *Lankester K 114* (K), *298* (K).

2. CLIDEMIA CILIATA Don, Mem. Wern. Soc. **4**: 309. 1823

Calophysa ciliata Triana, Trans. Linn. Soc. Bot. **28**: 140. 1871.

Although the type collection is from Peru, there is no doubt that the plants from Venezuela and Colombia are conspecific. Formicaria are usually not produced and have been noted only on *Pittier 9830*, where they have the usual didymous form and are thinly stellate and sparsely hirsute.

PERU—Chicoplaya: *Ruiz* (isotype, B). Dept. Ayacucho, Aina: *Killip & Smith 22704* (Y).

BOLIVIA—Yungas: *Bang 448* (Y). Nord Yungas: *Buchtien 3864* (Y).

COLOMBIA—Santa Marta: *H. H. Smith 2517* (Y).

VENEZUELA—Near Caracas: *Pittier 9830* (Y); *Allart 17* (Y); *Woronow 7439* (Y).

3. **Clidemia tococoidea** (DC.) comb. nov.

Calophysa tococoidea DC. Prodr. **3**: 166. 1828.
Maieta tococoidea (DC.) Cogn. Fl. Bras. **14**[4]: 465. 1888.
Maieta tococoidea var. *Watsonii* Cogn. Monog. Phaner. **7**: 979. 1891.

De Candolle does not cite the type definitely, merely stating that he saw specimens in the herbarium at Paris. Cogniaux mentions a collection of Bonpland, which is probably the type, as it is the only one cited which antedates the Prodromus.

The plants from north of Panama are much hairier and have leaves somewhat larger and proportionately broader, with 7–9 primaries; these were distinguished as a variety by Cogniaux. In all the Amazon sheets except *Ule 5828*, glandular pubescence is lacking and the hypanthium is free from setae. In this one collection the stem, petioles, formicaria, inflorescence, and hypanthium are glandular-hirsute, while the exterior teeth, so conspicuously setose in the others, are here minutely stellate with a single terminal bristle.

BRAZIL—Barcellos: *Traill 304* (K); Jurua Miry: *Ule 5828* (B, K); San Joaquim: *Ule 6048* (B, K); along the Rio Negro: *Spruce 2032* (B, C, K, Y).[3]

[3] Spruce had a habit of collecting under the same number specimens from widely separate localities and widely different dates. Sometimes these discrepancies were obscured by the provision of a uniform herbarium label and sometimes further confused by different herbarium labels for the same thing. The number here cited was collected

PERU—Maynas: *Poeppig 1794* (B).

PANAMA—Cricamola Valley: *Cooper 480* (F, Y).

COSTA RICA—Prov. Talamanca, Tsâki: *Tonduz 9597* (F, N); Zhorquin: *Tonduz 8575* (N).[4]

BRITISH HONDURAS—Middlesex: *Schipp 470* (G).

4. Clidemia setosa (Triana) comb. nov.

Calophysa setosa Triana, Jour. Bot. **5**: 209. 1867.
Maieta setosa (Triana) Cogn. Fl. Bras. **14**[4]: 462. 1888.

While the structure of the flowers and the general facies is quite uniform, the amount and distribution of the pubescence varies greatly. On the stem and petioles the hairs are always long, copious, and reflexed; the leaves range from glabrous to densely hirsute on either surface. The species is based on a collection of Seemann from Nicaragua, which I have not seen. The description is so plain and the usage of later students so definite that there is no doubt concerning the application of the name.

MEXICO—Vera Cruz, Chinantla: *Galeotti 2963* (B); Misantla: *Hahn* (K). Oaxaca, Lacoba and Teotalcingo: *Liebmann 35* (G, K, N). Chiapas, Finca Mexiquito: *Purpus 6778* (F, G, N, Y).

GUATEMALA—Chahná: *Johnson 466* (N); San Cristobal: *Tejada 245* (N). Dept. Huehuetenango, Huehuetenango: *Tejada 334* (N). Dept. Alta Verapaz, Cubilquitz: *Türckheim 7865* (B, F, G, K, N, Y), *II 411* (N); Finca Sepacuite: *Cook & Griggs 184* (N), *480* (N); Trece Aguas: *Cook & Doyle 15* (F, N); Pansamalá: Türckheim 991 (B, G, K, N, Y). Eastern portions of Vera Paz and Chiquimula: *Watson 227* (G).

BRITISH HONDURAS—Belize: *Cook & Martin 23* (N).

HONDURAS—Coyol: *Carleton 506* (N). Dept. Atlántida, near Tela: *Standley 56753* (F).

COSTA RICA—Forêts de Tuis: *Tonduz 8284* (N). Prov. Guanacaste, Los Ayotes: *Standley & Valerio 45341* (N). Prov. San José, La Hondura: *Standley 37597* (N); forêts de Las Vueltas: *Tonduz 13124* (B, F, N). Prov. Cartago, El Muñeco: *Standley 33647* (N); Pejivalle: *Standley & Valerio 47154* (N).

5. Clidemia pubescens sp. nov.

Caule gracile cum petiolis et inflorescentia tenuiter pubescente et longe setoso pilis flavidis patulis vel reflexis; petiolis brevibus vel elongatis; formicariis epiphyllis semiovoideis paulum setosis vel glabris; laminis membranaceis elliptico-oblongis saepe falcatis abrupte breviterque acuminatis basi rotundatis vel subcordatis supra glabris vel setis paucis inspersis, subtus ad venas venulasque pubescentibus ad basin venarum primariarum breviter setosis; inflorescentia parva pauciflora longe pedunculata; floribus 4-meris; hypanthio fructifero subglabro; calycis tubo parce setoso; ovario 4-loculare.

in at least three places, on the Rio Negro below Barcellos, on the same river above the mouth of the Casiquiare, and at Piedra de Capibara on the Rio Casiquiare.

[4] The old province of Talamanca in Costa Rica no longer exists and the southern part of its original territory now lies in Panama. The collection cited and probably most of Tonduz' other collections in this genus came from the transferred area.

Stems woody, thinly pubescent and also freely setose when young with stiff, slender, yellowish hairs as much as 10 mm. long, the same indument covering the petioles and inflorescence; petioles slender, 2—7 cm. long; formicaria on the base of the blade, semi-ovoid, 10—15 mm. long, conspicuously 2-lobed, glabrous or sparingly setose; blades membranous, elliptic-oblong, often somewhat falcate, as much as 15 by 6.5 cm., abruptly short-acuminate, nearly entire, finely ciliate, rounded or subcordate at base, apparently glabrous above, but actually with a few long setae 10–15 mm. apart in the distal half, finely pubescent beneath on all the veins and veinlets, setose on the primaries near the base, 5-pli-nerved; peduncle elongate, slender, terminated by a few-flowered cyme; flowers 4-merous; fruiting hypanthium globose, glabrous; calyx-tube sparsely setose; ovary 4-celled.

The plant apparently does not reach a great size, one specimen having bloomed at a height of only 25 cm.

COSTA RICA—Forêts de la Boca de Zhorquin, Prov. Talamanca (now in Panama, Dept. Bocas del Toro): *Tonduz 8574*, type (and only fertile specimen examined) in the National Herbarium, no. 1361798, isotype in Field Museum, no. 576466; près du ruisseau de Kitadiku, Talamanca: *Tonduz 9377* (F, N).

6. **Clidemia spectabilis** sp. nov.

Caule herbaceo longissime setoso pilis flavidis patulis; petiolis brevibus dense setosis; formicariis epiphyllis parvis; laminis late ellipticis abrupte acuminatis basi rotundatis 7-pli-nerviis supra crasse bullatis setosisque subtus ad venulas pubescentibus ad venas pubescentibus et setosis; inflorescentia densa multiflora pedunculata setosa, bracteis setaceis elongatis; floribus pedicellatis 5-meris; hypanthio campanulato breviter villoso; sepalis ovatis obtusis, dentibus exterioribus sepala duplo excedentibus subulatis setosis; calycis tubo longissime setoso; staminibus isomorphis, antheris oblongis lateraliter complanatis poro terminale dehiscentibus; ovario infero 5-loculare rostro brevissimo coronato.

Stem slender, herbaceous, densely covered with slender, yellowish, spreading bristles as much as 15 mm. long; leaves isomorphic; petioles 1–2 cm. long, setose like the stem; formicaria epiphyllous, densely setose, about 1 cm. long; blades firm, broadly elliptic, 20 cm. long, 17 cm. wide, abruptly short-acuminate, nearly entire, rounded at base, 7-pli-nerved, heavily bullate above, each conic projection tipped with a slender seta 8–10 mm. long, deeply foveolate beneath, villous-pubescent with short hairs on the tertiaries, setose on the primaries and secondaries with hairs up to 8 mm. long, underlaid by short villous hairs; inflorescence from the upper axils, many-flowered, compact, the peduncle 3 cm. long, densely pubescent with slender hairs 2 mm. long and also densely long-setose, pedicels 2.5 mm. long; flowers 5-merous; hypanthium campanulate, 3 mm. long to the torus, densely villous with fine crooked hairs 0.4 mm. long; calyx-tube prolonged 0.7 mm., somewhat flaring, pubescent

like the hypanthium and also with 15–20 slender setae 8–9 mm. long; sepals ovate, obtuse, 0.7 mm. long, finely glandular-ciliate; exterior teeth stoutly subulate, 2 mm. long, villous at base and with 3 or 4 long setae; petals elliptic, 5–6 mm. long; stamens isomorphic; filaments flat, glabrous, 2 mm. long; anthers stoutly oblong, 2 mm. long, laterally flattened, opening by a terminal pore; connective neither appendaged nor prolonged, but elevated into a low dorsal ridge near the base; ovary wholly inferior, 5-celled, its summit prolonged into a short glabrous beak; style slender, 6.5 mm. long; stigma capitate.

COSTA RICA—El Muñeco, alt. 1500 m.: *Stork 2717* (type in Field Museum, no. 598560).

'Herb on deep forest floor, conspicuous for its extreme hirsuteness. Fruits cerulean blue.'—Stork. It resembles *C. setosa* in general habit but may be distinguished at a glance by its remarkably bullate leaves, as well as the other more technical characters mentioned in the key.

7. **Clidemia juruensis** (Pilger) comb. nov.[5]

Maieta juruensis Pilger, Verh. Bot. Ver. Brandenb. **47**: 178. 1905.

The isomorphic, obovate leaves, long cuneate at base to a nearly sessile formicarium, give it an aspect quite unlike the other myrmecophilous species of the genus and suggesting rather a relation to *Tococa*. The axillary flowers and the form of the stamens are nevertheless typical of *Clidemia*.

BRAZIL—Jurua Miry: *Ule 5449* (type, B, K).

PERU—Dept. Loreto, Catalina on the Río Ucayali: *Huber 1511* (N); Santa Rosa: *Killip & Smith 28754* (Y).

8. **Clidemia foliosa** sp. nov.

Ramis gracilibus minute stellatis et longiore glanduloso-hirsutis; petiolis brevibus dense stellatis sparse glandulosis; formicariis semi-ovoideis partim ad petiolum partim ad laminam adnatis hirsutis dorso foliolis paucis ornatis; laminis anguste ellipticis acuminatis crenulatis ad basin inaequilateralem obtusis 5–7-pli-nerviis, venis in quoque jugo alternatim orientibus, utrinque pilosis; inflorescentia parva ramosa glanduloso-pilosa, bracteis setaceis elongatis; floribus 5-meribus sessilibus; hypanthio tubuloso minute stellato; dentibus exterioribus lineari-subulatis hypanthium aequantibus pilis glandulosis perpaucis inspersis.

Stems slender, minutely stellate and freely glandular-hirsute; large leaves: free petioles about 1 cm. long, rather densely stellate and sparsely glandular; formicaria semi-ovoid, 3–4 cm. long, of which the basal 5–10 mm. is entirely on the petiole, the distal portion extending up the blade to the base of the uppermost primaries, very sparsely and minutely stellate, freely glandular-

[5] In my opinion, the use of this specific name is not invalidated by the earlier publication of *Clidemia juruana* Ule.

hirsute, bearing along the dorsal median line 2–6 lanceolate or oblong leaflike appendages, each 2–6 mm. long; leaf-blades thin, narrowly elliptic, as much as 6 by 15 cm., abruptly acuminate, finely crenulate, obtuse or rounded at the inequilateral base, where one side is 3–8 mm. longer than the other, 5–7-pli-nerved, all except the upper pair of laterals more or less alternate, rather sparsely setose on both sides; small leaves: petioles 3–5 mm. long; formicaria none; blades ovate, 1–2 cm. long by two thirds as wide, cuspidate-acuminate, broadly rounded at base, 3-nerved; inflorescence (very immature) a small few-flowered panicle, glandular-hirsute and sparsely stellate; bracts setaceous, 2–4 mm. long; flowers 5-merous, sessile; hypanthium tubular, minutely stellate; exterior teeth linear-subulate, as long as the hypanthium, with a few long glandular hairs on each.

PERU—Dept. Loreto, Timbuchi on the Río Nanay: *Williams 933* (type in the herbarium of The New York Botanical Garden); Tierra Doble on the Río Nanay: *Williams 1058* (N).

9. **Clidemia heterophylla** (Desr.) comb. nov.[6]

Melastoma heterophylla Desr. Lam. Encyc. **4**: 34. 1796.
Tococa heterophylla Don, Mem. Wern. Soc. **4**: 305. 1823.
Calophysa heterophylla Triana, Trans. Linn. Soc. Bot. **28**: 140. 1871.
Maieta heterophylla DC. Prodr. **3**: 166. 1828.

PERU—Chicoplaya: *Ruiz* (B); Maynas Altas (probably Dept. San Martín): *Poeppig* without number (B).[7] Dept. Huanuco, between Monzon and Huallaga: *Weberbauer 3632* (B), *3665* (B), *3681* (B, N). Dept. Junín, Cahuapanas: *Killip & Smith 26774* (Y). Dept. Loreto, Balsapuerto: *Killip & Smith 28575* (Y), *28482* (Y).

10. **Clidemia Sprucei** nom. nov.

Calophysa dentata Triana, Trans. Linn. Soc. Bot. **28**: 140. 1871.
Maieta dentata (Triana) Cogn. Fl. Bras. **14**^{4}: 465. 1888.

Triana cited originally two collections, *Spruce* 4441 and *Lechler* 2306, but only a single locality 'in montibus secus flumen Mayo prope Tarapoto Peruviae orientalis.' Since this corresponds to the locality of the Spruce collection, that plant is accepted as the type. The use of the original specific name is prevented by the earlier *C. dentata* Don.

PERU—Tarapoto: *Spruce 4441* (K); San Govan: *Lechler 2306* (K, Y).

NEW YORK BOTANICAL GARDEN

[6] The Index Kewensis cites a *Clidemia heterophylla* Steud., which is merely a typographical error, the original name being *C. heteropila*.

[7] This is probably the same collection cited by Triana and Cogniaux as *Poeppig 2051* from Tocache, prov. Maynas. The Berlin sheet is sterile.

Studies of South American plants. I.
New or noteworthy plants from Peru and Amazonian Brazil

ALBERT C. SMITH

Recent collections from the Amazon valley have disclosed many interesting flowering plants of which some of those in the families *Moraceae*, *Loranthaceae*, *Olacaceae*, *Menispermaceae*, *Myristicaceae* and *Lauraceae* are considered in this paper. The collections were made by Mr. E. P. Killip and the writer in 1929 and by Mr. G. Klug in 1929 and 1930. All collections here cited are deposited in the herbarium of the New York Botanical Garden, and in each case there is a duplicate in the herbarium of the U. S. National Museum. The Killip & Smith collections are indicated in citations by '*KS*'. Most of the plants here considered were collected in the Department of Loreto in Peru, especially near the town of Iquitos, on the upper Amazon, and at Mishuyacu, near Iquitos. The elevation of both of these places is approximately 100 meters.

MORACEAE

TRYMATOCOCCUS AMAZONICA Poepp. & Endl. PERU—Loreto: Yurimaguas, on Río Huallaga, *KS 29052, 29114;* Iquitos, *KS 26997*. Yurimaguas is near the type locality, but the species is to be looked for from the lower Amazon as well.

POUROUMA CECROPIAEFOLIA Mart. PERU—Loreto: vicinity of Iquitos and along lower Río Huallaga, *KS 27381, 27932, 29839*. Previously known from the lower Amazon.

COUSSAPOA VILLOSA Poepp. & Endl. PERU—Loreto: lower Río Huallaga, *KS 28800*. Apparently rare; this collection is from near the type locality.

NAUCLEOPSIS MACROPHYLLA Miq. PERU—Loreto: Yurimaguas and vicinity, *KS 28179, 28244*. Our plant is probably identical with *N. Ulei* (Warb.) Ducke, the specific status of which is doubtful. It is probably fairly common in the region under consideration.

Dorstenia umbricola sp. nov. Herba semi-prostrata; caule basi decumbente simplice carnoso terete breviter pubescente; petiolis pubescentibus subteretibus; laminis oblongo-lanceolatis vel obovato-lanceolatis pergamentaceis, basi cuneatis vel truncatis, apice acutis, margine integris vel undulato-crenatis, supra glabris, subtus ad nervos parce pilosis, nervis lateralibus arcuato-adscendentibus cum nervo medio supra planis subtus elevatis; stipulis parvis lanceolato-ovatis deciduis; pedunculis axillaribus basi gracillimis, parce decidue breviter pilosis; receptaculo orbiculare concavo margine leviter tuberculato; floribus ♂ in ordines angustos dispositis, perianthio membranaceo glabro vel minute puberulo irregulare, staminibus 2, filamentis gracilibus

glabris, antheris globoso-didymis; floribus ♀ receptaculi locum medium occupantibus, ovariis 2–9 ovoideis, semi-immersis in alveolis delicatis, basi gracile affixis, stylo gracile apice bifido.

Semi-prostrate herb up to 2 decimeters high; stem decumbent at base, carnose, terete, pubescent with short spreading hairs up to 0.2 mm. long; petioles similarly pubescent, subterete, 5–13 mm. long; leaf-blades oblong-lanceolate or obovate-lanceolate, 8–10 cm. long, 2.5–3.2 cm. broad, cuneate or truncate at base, acute at apex, plane and entire or undulate-crenate at margins, pergamentaceous, glabrous and minutely foveolate above, sparsely pilose on nerves beneath (hairs pale, spreading, 0.2 mm. long), pinnate-veined, secondary nerves 7 or 8 per side, arcuate-ascending, connected near margins, with the midnerve plane above, raised beneath, veinlets reticulate, plane or slightly raised beneath; stipules lanceolate-ovate, 1–2 mm. long, soon deciduous; peduncles axillary, about 2.2 cm. long at maturity, slenderest at base, sparsely and deciduously short pilose; receptacle orbicular, concave, about 1.5 cm. in diameter at maturity, irregular at margins and slightly tuberculate; ♂ flowers limited to a narrow marginal region (sometimes also on narrow bands lying transversely across the receptacle); perianth membranous glabrous or minutely puberulus, irregularly cleft; stamens 2, filaments slender, glabrous, 0.5–0.8 mm. long, anthers globose-didymous, about 0.4 mm. in diameter; ♀ flowers occupying center of the receptacle; ovaries semi-immersed in delicate alveolae, attached by the slender base, 2–9 in number, ovoid, about 3.5 mm. by 1.5 mm.; style slender, 1–2 mm. long, bifid at apex.

Type, *KS 29639*, collected Sept. 20, 1929, in dense forest at Soledad, on Río Itaya, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species related to *D. nervosa* Desv. and *D. argentata* Hook. f. From the former it differs by having the ♂ and ♀ flowers on different portions of the receptacle, the petioles and peduncles shorter, etc. From the latter it differs by its non-variegated leaves and its less carnose receptacles which are less markedly tuberculate at the margins.

LORANTHACEAE

PSITTACANTHUS CRASSIFOLIUS Mart. Peru—Loreto: Mishuyacu, *Klug 119*. A well-marked species, characterized by its ternately arranged flowers, its short filaments attached near the apex of the perianth, and the numerous villose hairs within the perianth distally. It should be noted that our specimen has leaves up to 18 cm. long, the perianth up to 9 cm. long, the stamens attached 10 mm. below the perianth apex, and the anthers 5–6 mm. long. On this plant are also observed one or two spurs on each perianth lobe (the spurs fleshy, 1.5–2 mm. from apex of lobe, triangular, about 0.5 mm. long, often reduced). The perianth has a tendency to split below the contracted throat, but the apical portion bearing the stamens is rarely distinctly lobed.

Psittacanthus calcaratus sp. nov. Frutex parasiticus; ramulis validis subrugosis glabris subteretibus vel trigonis; petiolis rugosis glabris apice alatis; laminis coriaceis glabris utrinque stomatiferis oblongis vel ovato-oblongis leviter falcatis, basi attenuatis, apice rotundatis vel obtusis, margine integris et leviter revolutis, nervo medio prominente, nervis lateralibus adscendentibus elevatis; floribus grandis in paribus pedunculatis in racemo subterminale dispositis; pedunculis bracteatis (bracteis triangulari-ovatis); cupula subpatelliforme; calyculo cylindrico apice patulo; perigonio cylindrico gracile glabro carnoso, ultra medium dilatato, fauce contracta, lobis patulis linearibus acutis ad margines interiores calcaratis (calcaribus deltoideis carnosis); staminibus 6 perianthii lobis oppositis, filamentis carnosis glabris vel superne minute setosis, apice angustatis, antheras aequantibus, antheris lineari-oblongis laevibus dorso pubescentibus; stylo filiforme perianthii tubo paullo longiore, stigmate subgloboso.

Parasitic shrub; branchlets stout, subrugose, glabrous, brownish, subterete or trigonous; petioles rugose, glabrous, about 1 cm. long, winged above; leaf-blades thick coriaceous, glabrous, stomatiferous on both surfaces (stomata crowded, about 0.1 mm. long, about 30 per sq. mm. of surface above, slightly denser beneath), oblong or ovate-oblong, slightly falcate, 11–15 cm. long, 4–6 cm. broad, attenuate at base, rounded or obtuse at apex, entire and slightly revolute at margins, pinnate-veined, midvein stout, prominent on both surfaces, rugose, secondary veins 5–7 to a side, ascending, raised on both surfaces, veinlets obscurely reticulate; flowers large, arranged in pedunculate pairs on a subterminal raceme; rachis stout, 2–3 cm. long; peduncles about 5 mm. long, bract triangular-ovate, 1–1.5 mm. long; pedicels about 3 mm. long; cupula subpatelliform, about 2 mm. long and 4–5 mm. in diameter at rim; calyculus cylindric, flaring at apex, 5–6 mm. long, 2–2.5 mm. in diameter; perianth cylindric, 9–9.5 cm. long, slender, swollen slightly above middle, contracted at throat, flaring to lobes, glabrous, carnose, bright red, 6-lobed, lobes linear, 1–1.5 cm. long, 1.5 mm. broad, acute, recurved at maturity, each interior margin spurred about 1 mm. from apex (spurs triangular, about 0.8 mm. long and 0.5 mm. broad at base, pale, fleshy, thicker towards apex of lobe, forming pockets for anthers when young); stamens 6, opposite perianth lobes; filaments attached 11–12 mm. below apex of perianth, carnose, glabrous or minutely setose distally, 5–6 mm. long, narrowed at apex and attached to the anther dorsally near its base; anthers linear-oblong, about 6 mm. long and 1.5 mm. in diameter, bright yellow, smooth-surfaced, pubescent dorsally with several lax brown hairs up to 5 mm. long; style filiform, about 0.6 mm. in diameter, slightly longer than perianth at maturity; stigma subglobose, about 1.6 mm. in diameter.

Type, *Klug 694*, collected Dec., 1929, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is most nearly related to *P. clusiaefolius* (Willd.) Eichl., from which it differs in leaf shape and in the presence of paired spurs on the

perianth lobes. These spurs suggest *P. caudatus* Ule, a species which is very distinct in other respects.

PSITTACANTHUS PERONOPETALUS Eichl. Peru—Loreto: Mishuyacu, *Klug 1323*. From material from farther down the Amazon our specimen differs by its longer perianths (up to 6.5 cm. long) and its more noticeably mucronate anthers.

Psittacanthus peculiaris sp. nov. Frutex parasiticus; ramulis teretibus glabris fuscis vel cinereis; petiolis subrugosis glabris anguste alatis; laminis coriaceis glabris utrinque stomatiferis ovatis vel ovato-oblongis, basi attenuatis, apice acutis vel longe acuminatis, margine integris, nervo medio immerso, nervis lateralibus adscendentibus obscuris; floribus grandibus in cymis axillaribus dichotomis dispositis, glabris; bracteis late triangularibus; cupula oblique subpatelliforme; calyculo cylindrico apice patulo; perigonio carnoso 6-angulato tubuloso gracile apice ampliore, lobis linearibus ad apices cohaerentibus acutis, ad apices extus calcara carnosa oblonga horizontali gerentibus; staminibus 6 perianthii lobis oppositis, filamentis brevissimis ad perianthii apicem insertis et hoc loco villosis, antheris lineari-oblongis; stylo filiforme quam perianthii tubo longiore, stigmate ellipsoideo.

Parasitic shrub; branchlets terete, glabrous, brownish or cinereous; petioles subrugose, glabrous, 3–6 mm. long, narrowly winged; leaf-blades thick coriaceous, glabrous, dark green, stomatiferous on both surfaces (stomata minute, dense beneath, scattered above), ovate or ovate-oblong, attenuate or cuneate at base, acute or long-acuminate at apex, entire at margins, 9–16 cm. long, 3.5–7 cm. broad, pinnate-veined, midvein immersed, secondary veins obscure, usually 3 to a side, oriented in basal half of leaf, ascending, veinlets obscurely reticulate; flowers large, 4 to an inflorescence, in axillary dichotomous cymes, glabrous; first and second branches of inflorescence 2–4 mm. long, bracts broadly triangular, about 1 mm. long; pedicles about 3 mm. long; cupula obliquely subpatelliform, about 0.8 mm. long and 1.8 mm. in diameter at rim, irregular at the thin margin; calyculus cylindric, flaring at apex, about 3 mm. long and 1.3 mm. in diameter, irregular-margined; perianth 6-angled, tubular, about 5 cm. long, slender (about 1 mm. in diameter) near base, gradually increasing to 4 mm. in diameter above, carnose, bright red, 6-lobed, lobes linear, about 1.5 mm. across, adherent to apex (easily separable in dissection), acute, sharply incurved for the distal 1.5 mm., each bearing at this point on the exterior surface a fleshy oblong horizontal spur (spurs about 1.8 mm. long, 1.6 mm. broad, 0.5 mm. thick); stamens 6, opposite perianth lobes; filaments minute, about 1 mm. long, attached about 6 mm. below apex of perianth, at which point are several reddish-brown villose hairs about 3 mm. long, narrowed at apex and attached to the anther dorsally near its base; anthers linear-oblong, fitting into the pockets formed by the overarching perianth lobes, 4–4.5 mm. long, about 0.6 mm. in diameter; stigma ellipsoid, about 0.8 mm. in diameter.

Type, *KS 29967*, collected Sept. 27, 1929, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. Other collections from the same locality are: *Klug 118*, *1206*. Another collection, also from Loreto, is *KS 29653*, from Peña Blanca, on Río Itaya. It is a species which apparently stands alone in the possession of horizontal perianth spurs, which are so noticeable as to obscure, at a first glance, the true lobe apices. The remarkably short filaments are also noteworthy, the anthers appearing sessile on a slight internal swelling of the perianth. Its nearest relationship may be with *P. brachynema* Eichl. and *P. corynocephalus* Eichl., both of which have the reduced filaments. The adherence of perianth lobes to one another or their freedom does not seem a fundamental character in this genus.

PSITTACANTHUS CUCULLARIS (Lam.) Blume. PERU—Loreto: Mishuyacu, *Klug 1317*. Apparently not rare throughout Amazonian America.

PHTHIRUSA MICRANTHA Eichl. BRAZIL—Amazonas: Manáos, *KS 30187*. From the type locality.

OLACACEAE

Liriosma gracilis sp. nov. Frutex gracilis; ramulis subteretibus subrugosis fuscis glabris vel minute puberulis; petiolis subglabris rugosis apice alatis; laminis ovatis vel oblongo-ovatis opacis subcoriaceis, basi cuneatis vel acutis, apice acutis vel acuminatis, margine integris glabris vel supra ad nervum medium minute puberulis, nervo medio elevato, nervis lateralibus patulis elevatis; inflorescentia axillare breve racemosa, rachide gracile flexuosa striata minute puberula; floribus pedicellatis, cupula obconica, ad marginem membranacea, glabra vel parce puberula, perianthii lobis 6 aequalibus binis lanceolatis glabris apice recurvatis; staminibus 9(3 fertilibus 6 sterilibus), fertilibus cum perianthii lobis alternatis, filamentis pilosis, antheris oblongis; sterilibus perianthii lobis oppositis membranaceis gracilibus apice furcatis; stylo filiforme glabro, stigmate subhemisphaerico leviter 3-partito, ovario hemisphaerico dense minuteque puberulo.

Slender shrub up to 2 meters high; branchlets subterete, subrugose, fuscous, glabrous or minutely puberulous; petioles essentially glabrous, rugose, 2–4 mm. long, winged above; leaf-blades ovate or oblong-ovate, 6–7 cm. long, about 3 cm. broad, cuneate or acute at base, acute or acuminate at apex, entire and slightly membranous at margins, glabrous on both sides or minutely puberulous above on midnerve, opaque, subcoriaceous, dull green, pinnate-veined, midvein slightly raised on both surfaces, secondary veins 5–8 to a side, spreading, slightly elevated on both surfaces, veinlets obscurely reticulate; inflorescence axillary, short-racemose, 3–6-flowered; rachis slender, flexuose, striate, 4–6 mm. long, minutely puberulous (hairs pale, not exceeding 0.05 mm. in length); pedicels subrugose, puberulous like the rachis, about 2 mm. long, minutely bracteolate at base; cup obconical, glabrous or faintly puberulous,

petal represents a fusion of 2, but the fusion is quite complete. The stamens are opposite the petals, which form, by their inflexed edges, little pockets for the anthers.

Synandropus membranaceus sp. nov. Frutex scandens; ramulis gracilibus striatis glabris; petiolis subteretibus gracilibus decidue laxe pilosis; laminis membranaceis oblongis basi cordatis apice obtuse acuminatis apiculatisque margine serratis, supra glabris viridisque, subtus pallidis et glabris vel parce pilosis, e basi 5–9-nerviis, nervo medio prominente, nervis lateralibus patulis leviter elevatis; inflorescentia ♂ paniculata glabra bracteata bracteolataque; floribus ♂ fasciculatis bracteolatis graciliter pedicellatis, sepalis 3 exterioribus membranaceis deltoideis acutis patulis basi connatis, 3 interioribus membranaceis concavis ovatis, petalis 3 tenuiter carnosis oblongis ad marginem membranaceis, inflexis ad margines laterales; staminibus 3 petalis oppositis, filamentis molliter carnosis ad medium connatis apice liberis, antheris subglobosis bilocularibus rimis verticalibus lateralibus dehiscentibus; inflorescentia ♀ fructeque ignota.

High-climbing woody vine; branchlets slender, striate, with loose thin glabrous brownish bark; petioles subterete, slender, 1–5 cm. long, deciduously pilose with pale lax hairs up to 0.5 mm. long; leaf-blades oblong, 8–10 cm. long, 3–4.5 cm. broad, cordate at base, obtusely acuminate and apiculate at apex, serrate at margins (serrations 1 or 2 per centimeter on mature leaves, each terminating a somewhat salient veinlet), membranous, above glabrous and virid, beneath pallid and glabrous or sparsely pale-pilose (hairs up to 0.3 mm. long, sometimes about 10 per sq. mm. of surface on young leaves, deciduous), 5–9-nerved from the base, nerves spreading, midnerve prominent on both surfaces, principal lateral nerves usually 4 to a side, spreading, slightly elevated, veinlets copiously reticulate, plane; ♂ inflorescence arising from branchlets below leaves, panicled, glabrous in all parts, up to 25 cm. long and 12 cm. broad; primary rachis striate, slender, circumscribed at base by several minute deciduous bractlets, secondary branches up to 6 cm. long, each subtended by a membranous lanceolate bractlet 1.5–2 mm. long which sometimes also subtends a single flower or a small fascicle, tertiary branches similar, up up to 1 cm. long; flowers in fascicles of 2 or 3, each fascicle subtended by a membranous ovate acute bractlet about 1 mm. long; pedicels slender, up to 1.5 mm. long; exterior sepals 3, membranaceous, triangular-acute, connate at base, spreading, about 0.6 mm. long; interior sepals 3, membranous, concave, ovate, about 1.5 mm. long and 1.2 mm. broad; petals 3 (each presumably formed by the fusion of 2), thin-carnose, oblong, about 1 mm. long and broad, membranous towards margins, lateral margins inflexed; stamens 3, opposite the petals, somewhat fused; filaments delicately carnose, about 0.8 mm. long, fused half their length, free distally; anthers subspherical, about 0.4 mm. in diameter, 2-locular, opening by lateral vertical clefts; ♀ inflorescence and fruit unknown.

Type, *KS 30217*, collected in swampy jungle at Breves, Amazon estuary, state of Pará, Brazil, Oct. 23, 1929, and deposited in the herbarium of the New York Botanical Garden.

DISCIPHANIA LOBATA (Mart.) Eichl. Peru—Loreto: Mishuyacu, *Klug 423, 780*. Previously known from Amazonian Brazil.

ELISSARRHENA GRANDIFOLIA (Eichl.) Diels. PERU—Loreto: Balsapuerto (lower Río Huallaga basin), *KS 28665*; San Antonio, on Río Itaya, *KS 29337*. Previously known from Amazonian Brazil.

MYRISTICACEAE

IRYANTHERA LEPTOCLADA Mgf. PERU—Loreto: lower Río Huallaga, *KS 29272*. Another collection not far from the type locality (mouth of Río Morona).

VIROLA MOLLISSIMA (A. DC.) Warb. PERU—Loreto: Yurimaguas, lower Río Huallaga, *KS 29044*. Our specimen is in fruit and permits the following notes to be added to previous descriptions:

Fruiting inflorescence up to 7 cm. long, once- or twice-branched, densely and closely ferruginous tomentose (hairs 1–1.5 mm. long, with numerous lateral spur-like branches); fruit sessile, spherical, 1–1.5 cm. in diameter, covered with a tomentum like that of the rachis (hairs up to 2.5 mm. long).

Virola loretensis sp. nov. Arbor; ramulis subteretibus dense fulvo-tomentosis pilis ramosis; petiolis teretibus crassis tomentosis; laminis oblongis vel anguste obovato-oblongis, basi cordatis, apice acutissimis, supra mox glabris, subtus tomento obtectis, nervo medio supra plano subtus prominente, nervis lateralibus patulis rectis ante marginem confluentibus; inflorescentia ♂ axillare dense tomentosa paniculata multiflora; floribus fasciculatis bracteis fugacibus lanceolatis suffultis; floribus ♂ graciliter pedicellatis infundibuliformibus, perigonio trifido extus tomentoso intus glabro; antheris 3 linearibus connatis subacutis, quam columna paullo longioribus; inflorescentia ♀ quam masculina minus ramosa, floribus subsessilibus.

Tree 4–8 meters high; branchlets subterete, densely and apparently persistently tomentose (hairs 1.5–3.5 mm. long, multicellular, with numerous short horizontal spur-like branches, ferruginous); petioles similarly tomentose, terete, stout (2.5–4 mm. in diameter), 3–10 mm. long; leaf-blades oblong or narrowly obovate-oblong, 15–30 cm. long, 4–9 cm. broad, cordate (rarely rounded or truncate) at base, acute or gradually sharp-acuminate at apex, entire and slightly revolute at margins, brown, above glabrous and dull (tomentose on midnerve, sometimes on surface of very young leaves), beneath densely or sparsely tomentose with spreading branched hairs similar to those of the branchlets, most densely so on the nerves, pinnate-veined, midnerve nearly plane or slightly raised above, prominent beneath, secondary nerves 15–19 to a side, spreading at an angle of about 60 degrees, straight, parallel, arcuate and connected near margins, slightly impressed above, raised beneath,

tertiary nerves subparallel, nearly plane, veinlets copiously reticulate; ♂ inflorescence axillary, panicled, 3–5-times branched, many-flowered, up to 20 cm. long and 15 cm. broad, densely brown tomentose with hairs similar to those of the branchlets; bracts each subtending a group of 8–15 flowers, linear-lanceolate, about 3 mm. long, densely ferruginous tomentose dorsally and at margins (hairs similar to those of branchlets but frequently unbranched), glabrous within, soon deciduous; flowers in ultimate clusters of 4–13 in umbelliform panicles, pedicellate (pedicels slender, 0.25 mm. in diameter, 1–3 mm. long, ferruginous tomentose (hairs about 0.2 mm. long, branching, contracted to appear stellate), continuous with perianth); perianth infundibuliform, 1.5–2.5 mm. long, tomentose without (hairs similar to those of the pedicel, frequently 0.1 mm. long), glabrous within, 3 (rarely 4-)-fid about one-third its length, lobes ovate-deltoid, subacute; anthers 3(always?), connate, erect, linear, subacute at apex, about 0.6 mm. long, column glabrous, slightly shorter than the anthers (0.3–0.5 mm. long); ♀ inflorescence axillary, once- or twice-branched, up to 15 cm. long, many-flowered, tomentose as the ♂ inflorescence (hairs usually simple); flowers in ultimate clusters of 5–10, subsessile; perianth similar to that of ♂ flowers; ovary spherical, about 1.8 mm. in diameter, densely sericeo-tomentose (hairs usually simple, multicellular, up to 1 mm. long); stigma sessile.

Type, *KS 27359*, collected Aug. 9, 1929, in woods at Iquitos, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. Other collections, all from Loreto, are: Iquitos, *KS 27026*; Mishuyacu, *Klug 1502, 1543;* Peña Blanca, on Río Itaya, *KS 29671.* Description of the bracts is taken from *KS 27026*, of the ♀ inflorescence from *Klug 1502.* It is a very distinct species, probably most closely related to *V. officinalis* (Mart.) Warb. and *V. calophylla* Warb., from both of which it differs markedly in its long persistent hairs, and also in petiole, leaf, and flower dimensions.

VIROLA CALOPHYLLA Warb. PERU—Loreto: Mishuyacu, *KS 29933*, *Klug 188*, *473*, *533*. Possibly our specimens represent a variety of this Brazilian species; they have somewhat shorter petioles and pedicels.

COMPSONEURA CAPITELLATA (A. DC.) Warb. PERU—Loreto: Mishuyacu, *Klug 180.* The type of the species is from the Río Huallaga. Our plant has slightly larger stamens, but agrees in all important character with the description.

COMPSONEURA TESSMANNII Mgf. PERU—Junín: San Nicholas, Pichis Trail, alt. 1100 m., *KS 26053*. The description of this species, the type of which is from the upper Marañon, gives the leaf base as rotund, but the type collection and our specimen both show it to be acute or cuneate. In the present specimen the anthers are up to 1.5 mm. long, but in all essential features it agrees well with the above mentioned robust species.

Lauraceae

Cryptocarya robusta sp. nov. Arbor ca. 9 metralis; ramulis subteretibus, cortice glabro vel sericeo obtectis; petiolis supra planis subrugosis subglabris; laminis oblongis vel ellipticis subcoriaceis olivaceis basi cuneatis apice obtuse acuminatis, supra glabris, subtus minutissime sericeis vel glabris, nervo medio supra prominulo subtus prominente, nervis lateralibus rectis adscendentibus; inflorescentia paniculata pauciflora sericea; bacca parva globosa vel obovoidea, reliquis perianthii staminumque coronata; perianthii lobis trigonis; filamentis brevissimis glabris, antheris subtrigonis; ovario perianthii tubo immerso ellipsoideo glabro.

Tree 6–9 meters high; branchlets subterete, glabrous or minutely sericeous when young; petioles flattened above, 10–12 mm. long, about 2 mm. in diameter, subrugose, essentially glabrous; leaf-blades oblong or elliptic, 17–22 cm. long, 6–9 cm. broad, cuneate at base, obtusely acuminate at apex, entire at margins, subcoriaceous, olivaceous, glabrous above, glabrous or minutely sericeous beneath (hairs pale, closely appressed and dense when present, about 0.1 mm. long), pinnate-veined, midnerve slightly raised above, prominent beneath, secondary nerves 4 or 5 per side, straight, ascending, arcuate near margins, nearly plane above, raised beneath, veinlets reticulate, slightly raised beneath; inflorescence panicled, about 7 cm. long in our specimen, once-branched, branches of inflorescence faintly striate, subterete, minutely and densely pale sericeous; young fruits 15–25 to an inflorescence, pedicellate (pedicels 3–7 mm. long, terete, minutely sericeous), subspherical or obovoid, 4–6 mm. in diameter, composed of a thick enlarged perianth tube, surmounted by remnants of perianth lobes and stamens; perianth lobes 6, slightly imbricate, triangular, acute, about 0.7 mm. in length and breadth; first and second series of stamens 3 each, anthers subtriangular, about 0.35 mm. in length and breadth, opening introrsely, filaments stout, short (0.1 mm. long), apparently glabrous and free from the perianth lobes; third and fourth series of stamens not observed; ovary carnose, ellipsoid, about 3 mm. long in our specimen, completely enclosed in the perianth tube, attached only at base; stigma not observed.

Type, *KS 26077*, collected July 4, 1929, in dense forest at San Nicholas, Pichis Trail, dept. Junín, Peru, alt. 1100 m., and deposited in the herbarium of the New York Botanical Garden. It is a very distinct plant, with larger leaves than any other species of the genus. Its nearest ally appears to be *C. pachycarpa* Gleason, with which it has in common an unusually thickened perianth tube.

Aniba compacta sp. nov. Arbor ca. 18 metralis; ramis ramulisque leviter striatis cinereis glabris vel minute pulverulentis bene foliatis; petiolis supra leviter canaliculatis subrugosis, decidue pulverulentis; laminis obovatis vel oblongo-obovatis coriaceis fuscis, basi cuneato-attenuatis, apice obtuse breviter acuminatis, glabris vel parce pulverulentis ad basin, nervo medio promi-

nente, nervis lateralibus patulis, arcuatis ad marginem; inflorescentia paniculata multiflora, dense cinereo-tomentella; floribus hermaphroditis dense tomentellis graciliter pedicellatis, perianthii tubo prismatico, lobis ovatis subacutis, intus ad apicem glabris; androecei seriebus 2 exterioribus fertilibus, filamentis robustis antheras subaequantibus, antheris subtrigonis obtusis breviter pilosis; staminodiis ser. III. magnis oblongis breviter pilosis, basi glandulis binis magnis suffultis; ovario perianthii tubo immerso, ellipsoideo glabro, stylo gracile, stigmate truncato.

Tree up to 18 meters high; branches and branchlets lightly striate, cinereous, glabrous or minutely pulverulent when young; petioles shallowly canaliculate above, subrugose, deciduously pulverulent, 12–18 mm. long; leaf-blades obovate or oblong-obovate, 10–15 cm. long, 3.5–6.5 cm. broad, cuneate-attenuate at base, obtuse or bluntly short-acuminate at apex, entire and plane at margins, coriaceous, fuscescent, glabrous or faintly pulverulent towards base on both surfaces, pinnate-veined, midvein stout, raised on both surfaces, secondary veins 8–12 to a side, spreading, arcuate and obscurely connected near margins, slightly raised above, plane or slightly impressed beneath, veinlets closely reticulate, impressed on both surfaces; inflorescence panicled, once- or twice-branched, up to 13 cm. long, many-flowered, branches of inflorescence striate, densely cinereous-tomentellous (hairs about 0.1 mm. long), secondary branches up to 2 cm. long; flowers solitary or in clusters of 2 or 3, bracteolate at base (bractlets oblong, densely tomentellous, 1–2 mm. long, soon deciduous), pedicellate (pedicels 3–6 mm. long when mature, tomentellous), 3–3.5 mm. long, densely tomentellous; perianth tube short subcylindric or prismatic, about 1.8 mm. long and 2 mm. in diameter, lobes 6, subequal, erect, narrowly imbricate, broadly ovate, subacute or rounded, about 1.3 mm. long and 1.5 mm. broad, glabrous within distally, pilose at base; stamens 9; first and second series: fertile, filaments stout, about 0.5 mm. long and 0.8 mm. broad, densely short-pilose, anthers deltoid, about 0.5 mm. long, obtuse at apex, short-pilose, bilocular, opening introrsely; third series: sterile, oblong, about 1.3 mm. long and 0.4 mm. broad, blunt at apex, densely short-pilose, biglandular at base (glands subspherical, sessile, about 0.5 mm. in diameter); ovary ellipsoid, glabrous, completely immersed in perianth tube, about 1 mm. long and 0.5 mm. broad at anthesis; style slender, 1.5 mm. long, stigma truncate.

Type, *Klug 608*, collected Oct.–Nov., 1929, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a very distinct species, related to *A. Canelilla* (HBK.) Mez, with which it has in common a sterile third series of stamens, but from which it differs by its long many-flowered inflorescence, its large flowers with equal perianth segments, its pilose filaments, etc. It may also bear a relationship to *A. citrifolia* (Nees) Mez, from which it differs by having its veinlets immersed, its perianth tube longer than the lobes, its filaments shorter, its third series of stamens sterile, and its style longer.

ANIBA PANURENSIS (Meissn.) Mez. PERU—Loreto: Mishuyacu, *Klug 409*. Previously known from Brazil; our plant is exactly similar to *Spruce 2603* from the Río Uaupes.

Aniba reticulata sp. nov. Arbor; ramis ramulisque leviter striatis cinereis vel fuscis, parce pilosulis vel glabris; petiolis subteretibus rugosis nigrescentibus glabris; laminis oblongo-ovatis chartaceis olivaceis, basi longe cuneatis, apice breviter acuminatis, glabris vel parce pilosis, nervo medio utrinque elevato, nervis lateralibus adscendentibus; inflorescentia paniculata multiflora, parce pilosa; floribus hermaphroditis graciliter pedicellatis extus pilosis, perianthii tubo obconico, lobis ovatis reflexis, intus dense breviter velutinis, androecei seriebus 3 fertilibus, filamentis brevissimis, seriei tertiae basi glandulis binis sessilibus suffultis, antheris ovoideis, apice obtusis vel leviter emarginatis; ovario subgloboso glabro, stigmate subsessile.

Tree; branches and branchlets lightly striate, cinereous or brownish, minutely and sparsely pilosulous when young, soon glabrous; petioles subterete, rugose, 6–10 mm. long, narrowly winged above, nigrescent, essentially glabrous; leaf-blades oblong-ovate, 8–13 cm. long, 3.5–4.5 cm. broad, long-cuneate at base, bluntly short-acuminate at apex, entire at margins, chartaceous, olivaceous, glabrous on both surfaces or minutely and sparsely pilose (hairs pale brown, spreading, about 0.2 mm. long, especially on the nerves), pinnate-veined, secondary nerves 5 or 6 to a side, ascending, with the midnerve raised on both surfaces, veinlets copiously reticulate, elevated on both surfaces; inflorescence panicled, 2- or 3-times branched, up to 9 cm. long, about 100-flowered, branches of inflorescence nigrescent, lightly striate, sparsely pilose (hairs pale, about 0.1 mm. long), secondary branches less than 1 cm. long; flowers solitary or in fascicles of 2 or 3, bracteolate at base (bractlets oblong, about 1 mm. long, pilose), pedicellate (pedicels up to 5 mm. long, pilose), about 3 mm. long and 4 mm. in diameter when expanded, pilose without; perianth tube obconical, about 2 mm. long, lobes 6, subequal, reflexed at maturity, broadly ovate, 2–2.5 mm. long and broad, densely short-velutinous within (hairs pale brown, minute, forming a thin close tomentum); stamens 9, all fertile with 2-locular anthers; first and second series: filaments minute, contracted, glabrous, about 0.1 mm. long, anthers broadly ovoid, about 0.4 mm. long and 0.7 mm. broad, obtuse or lightly emarginate at apex, opening introrsely; third series: filaments contracted, short, obscured by 2 large flat semi-confluent glands, anthers as those of the outer series, opening extrorsely; ovary subglobose, about 1.5 mm. in diameter, glabrous, stigma subsessile, irregularly peltate, about 1 mm. in diameter.

Type, *KS 28050*, collected Aug. 25, 1929, in woods at Yurimaguas, on lower Río Huallaga, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species related to *A. Muelleriana* Mez, from which it differs by its larger flowers, its contracted and glabrous filaments, and its short style.

ANIBA CITRIFOLIA (Nees) Mez. PERU—Loreto: Mishuyacu, *Klug 1313.* Our plant has shorter pedicels and larger leaves than typical material from Brazil.

ACRODICLIDIUM ARMENIACUM (Nees) Mez. PERU—Loreto: Mishuyacu, *Klug 1267, 1379.* Apparently a rare species, previously collected by Poeppig. It is well-marked by its ovate-lanceolate leaves, its slender flexuose pedicels, and its introrse-apically dehiscing anthers.

Acrodiclidium latifolium sp. nov. Arbor ca. 4 metralis; ramulis subteretibus rectis dense ferrugineo-sericeis; petiolis subrugosis supra canaliculatis gracilibus pilosis; laminis oblongis vel late ovato-oblongis subcoriaceis olivaceis, basi late cuneatis, apice caudato-acuminatis, supra glabris vel parce pilosis, subtus ferrugineo-pilosis, nervo medio prominente, nervis lateralibus arcuato-adscendentibus supra subplanis subtus prominentibus; inflorescentia paniculata multiflora, dense sericea modo ramulorum; floribus hermaphroditis graciliter pedicellatis sericeis, perianthii tubo obconico vel breviter cylindrico, lobis oblongis subacutis intus glabris; staminibus serierum 2 exteriorum sterilibus ovato-oblongis, seriei tertiae fertilibus, filamentis quam antheris 2–3-plo longioribus, basi biglandulosis, antheris bilocularibus extrorsis; ovario ellipsoideo-ovoideo glabro subrugoso immerso, stylum aequante.

Tree about 4 meters high; branchlets subterete, straight, densely and closely ferruginous sericeous (hairs appressed, about 0.1 mm. long, completely covering young branchlets, deciduous); petioles subrugose, canaliculate above, 12–15 mm. long, slender (less than 2 mm. in diameter), appressed pilose (hairs often longer than those of the branchlets); leaf-blades oblong or broadly ovate-oblong, 15–19 cm. long, 7–9 cm. broad, broadly cuneate at base, caudate-acuminate at apex, plane and entire at margins, subcoriaceous, olivaceous, glabrous above or pilose on and near the principal veins (hairs appressed, about 0.3 mm. long), regularly pale-ferruginous-pilose beneath (hairs subappressed, 0.3–0.4 mm. long, densest on the nerves, 15–30 per sq. mm. of surface), pinnate-veined, midnerve raised above, prominent beneath, secondary nerves 5–7 per side, arcuate-ascending, nearly plane above, prominent beneath, veinlets reticulate, subimmersed; inflorescence panicled, 7–9 cm. long, solitary in leaf axils, twice-branched, about 100-flowered, branches of inflorescence terete, densely sericeous as the branchlets; flowers in fascicles of 2 or 3, minutely bracteolate at base, pedicellate (pedicels sericeous, slender, 1–4 mm. long), 1.5–2 mm. long; perianth tube obconical or short-cylindric, 1.3–1.5 mm. long, about 1.5 mm. in diameter, lobes 6, incurved, equal, closely sericeous without (hairs 0.1 mm. long), glabrous within, oblong, subacute, 0.6–0.8 mm. long, 0.7 mm. broad; stamens 9; first and second series: sterile, ovate-oblong, rounded at apex, 0.5 mm. long and broad, slightly concave, sparsely short-pilose without; third series: fertile, oblong, 0.6 mm. long, 0.5 mm. broad, filaments 2 or 3 times as long as the anthers, sparsely pilose at base, biglandular at base (glands nigrescent, globose, sessile, about 0.15 mm. in

diameter), anthers bilocular, locules opening extrorse-apically; ovary elliptic-ovoid, about 0.5 mm. long at anthesis, glabrous, subrugose, immersed, style about as long or slightly shorter, stigma truncate.

Type, *Klug 30*, collected Oct.–Nov., 1929, in clearing in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species closely allied to *A. brasiliense* Nees and *A. aureum* Huber, from both of which it differs by having its leaves larger and oblong rather than ovate-lanceolate and its inflorescence longer. Our plant has flowers slightly larger than those of *A. brasiliense* and the ovary strictly glabrous rather than sparsely short-pilose (as it is in *A. brasiliense* regardless of the description).

Acrodiclidium macrophyllum sp. nov. Arbor ca. 4 metralis; ramulis subteretibus cinereis glabris; petiolis valde canaliculatis crassis glabris; laminis oblongo-ovatis coriaceis, olivaceis vel fuscis, basi cuneatis, apice acuminatis (?), supra glabris subtus minute pilosis, nervo medio prominente, nervis lateralibus patulis arcuatis ad marginem; inflorescentia racemoso-paniculata, 20–40-floris, pilosa; floribus hermaphroditis pedicellatis glabris, perianthii tubo obconico subrugoso carnoso, lobis erectis ovatis; staminibus serierum 2 exteriorum sterilibus spathulatis vel obovatis glabris, seriei tertiae fertilibus, filamentis antheras aequantibus dense pilosis basi biglandulosis, antheris carnosis subglobosis extrorsis; ovario ellipsoideo-ovoideo glabro semi-immerso stylum aequante.

Tree 4 meters high; branchlets subterete, cinereous, glabrous; petioles deeply canaliculate, 20–30 mm. long, stout (2–4 mm. in diameter), essentially glabrous; leaf-blades oblong-ovate, 25–33 cm. long, 11–13 cm. broad, cuneate at base, acuminate at apex (?, incomplete in our specimen), entire and narrowly cartilaginous at margins, coriaceous, olivaceous above, brownish beneath, glabrous above, sparsely and minutely pilose beneath (hairs spreading, pale, translucent, about 0.1 mm. long, soon deciduous), pinnate-veined, mid-nerve prominent on both surfaces, secondary nerves about 8 per side, spreading, ascending near margins, raised on both surfaces, veinlets reticulate, slightly elevated beneath, the finer ones obscure; inflorescence racemose-panicled, once-branched, up to 6 cm. long on our specimen (conceivably much longer), 20–40-flowered, branches of inflorescence subterete, pilose with pale spreading hairs up to 0.3 mm. long; flowers solitary or in fascicles of 2 or 3, bracteate at base (bracts oblong, sparsely pilose, about 1 mm. long), pedicellate (pedicels essentially glabrous, 1.5–2.5 mm. long), glabrous, about 3 mm. long; perianth tube obconical, 1–1.5 mm. long, subrugose, carnose, lobes 6, subequal, erect, slightly concave, ovate, about 1.4 mm. long and 1. 2 mm. broad; stamens 9; first and second series: sterile, spatulate or obovate, glabrous, about 0.9 mm. long and 0.7 mm. broad; third series: fertile, filaments stout, about 0.6 mm. long, densely pilose (hairs brown, straight, ascending, about 0.2 mm. long), biglandular at base (glands subglobose, about 0.3 mm.

in diameter, minutely stipitate with short-pilose stalks), anthers carnose, subglobose, about 0.7 mm. in diameter, opening extrorse-apically; ovary elliptic-ovoid, about 0.8 mm. in diameter, glabrous, semi-immersed, style about as long as ovary, stigma truncate.

Type, *Klug 80*, collected Oct.–Nov., 1929, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a very distinctive species, most closely allied to *A. brasiliense* Nees and *A. latifolium* (above described). Both of these species, however, have much smaller leaves and densely strigose flowers, as well as differences in staminal measurements, etc. In leaf size and shape, our species is suggestive of *A. Canelo* Rose, an unpublished Ecuadorean species which is not to be confused with *A. Canella* (Meissn.) Mez. *A. Canelo*, known in fruit only, has veinlets much more prominent than our plant and leaves somewhat narrower.

Endlicheria mishuyacensis sp. nov. Arbor ca. 10 metralis; ramis ramulisque gracilibus striatis cinereis decidue strigosis; petiolis canaliculatis rugosis gracilibus strigosis vel subglabris; laminis oblongo-lanceolatis vel anguste obovatis chartaceis, basi attenuatis, apice obtuse acuminatis, glabris vel parce strigosis, nervo medio prominente, nervis lateralibus arcuatis adscendentibus ad marginem; inflorescentia ♂ paniculata subflexuosa pauciflora, minute strigosa; floribus ♂ minute pallido-strigosis breviter pedicellatis, perianthii tubo obconico, lobis oblongo-ovatis intus glabris; androecei seriebus 3 omnibus fertilibus, filamentis carnosis dilatatis, basi eglandulosis, antheris filamenta aequantibus apice subacutis; inflorescentia ♀ adhuc ignota; bacca ovoidea vel obovoidea, cupula subsessile.

Tree 6–10 meters high; branches and branchlets cinereous, slender, striate, when young minutely strigose (hairs appressed, brown, up to 0.2 mm. long), becoming glabrous; petioles canaliculate above, rugose, 3–10 mm. long, slender (1–1.5 mm. in diameter), winged distally, strigose as the branchlets or subglabrous; leaf-blades oblong-lanceolate or narrowly obovate, 7–16 cm. long, 2–5.5 cm. broad, attenuate at base, obtusely acuminate at apex, entire and slightly thickened at margins, chartaceous, dark green, somewhat lustrous, glabrous or sparsely strigose on both surfaces (hairs appressed, scattered, about 0.2 mm. long, densest near the midnerve, soon deciduous), venation pinnate, midnerve prominent on both surfaces, secondary nerves 4–6 per side, arcuate, ascending near margins, raised on both surfaces, veinlets copiously and prominently reticulate; ♂ inflorescence panicled, subflexuose, 3–4 cm. long, about 10–20-flowered, rachis and secondary branches slender, violaceous, striate, minutely strigose as the branchlets; flowers minutely pale-strigose without with appressed hairs about 0.1 mm. long, short-pedicellate (pedicels up to 1.5 mm. long); perianth tube obconical, 1–1.3 mm. long, limb spreading, 6-lobed, lobes thin carnose, oblong-ovate, 1–1.3 mm. long, 0.8 mm. broad, glabrous within; stamens 9, all fertile with short carnose dilated filaments and

2-locular anthers, eglandular at base; first and second series: 0.7–0.9 mm. long, connective extended slightly beyond anthers and marked introrsely with a few scattered minute yellowish glands, anthers about as long as filaments, stout, opening introrse-laterally; third series: similar, connective eglandular, anthers opening extrorse-laterally; fourth series and gynecium completely lacking; ♀ inflorescence not seen; calyx in fruit subsessile, dull red, about 13 mm. in diameter at summit; fruit ovoid or obovoid, dark green, up to 30 mm. long and 18 mm. in diameter at middle, imbedded in the cup about one-fourth its length.

Type, *Klug 204*, collected Oct.–Nov., 1929, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. Other collections from the same locality are: *Klug 411*, *621*, *703*, *KS 29870* (from which the fruit is described). A plant from Balsapuerto, lower Río Huallaga basin, *KS 28400*, is also referable here. It is a species allied to *E. dysodantha* (R. & P.) Mez, from which it differs by having its pedicels shorter, its flowers about twice as large, and its third series of filaments eglandular. Its relationship to recently described species of lowland Peru is not close.

ENDLICHERIA ARUNCIFLORA (Meissn.) Mez. Peru—Loreto: Mishuyacu, *Klug 1264*, *1403*. Our specimen has leaves up to 25 cm. long and 8.5 cm. broad. It is apparently a rare species, but no important differences are apparent between the present specimens and the description and plate (typical material is not available to me).

ENDLICHERIA ANOMALA Nees. PERU—Loreto: Iquitos, *KS 27192;* Mishuyacu, *KS 29959*, *Klug 728*. Local name: 'Canela.' Evidently a widely distributed species from Guiana to Amazonian Peru. It was collected on the Río Ucayali by Tessmann.

PERSEA BOLIVIENSIS Mez & Rusby. PERU—Junín: San Ramon, alt. 1400–1700 m., *KS 24831*. Previously known from Bolivia.

Phoebe pichisensis sp. nov. Arbor ca. 10 metralis; ramis ramulisque subteretibus leviter striatis fuscis vel stramineis decidue pulverulentis; petiolis leviter canaliculatis gracilibus puberulis; laminis ovato-oblongis chartaceis, basi cuneatis, apice obtuse breviter acuminatis, supra subglabris, subtus pilosis, nervo medio supra plano subtus elevato, nervis lateralibus arcuato-adscendentibus; inflorescentia paniculata multiflora minute puberula; floribus hermaphroditis extus parce puberulis breviter pedicellatis, perianthii tubo late obconico, lobis ovato-oblongis; androecei seriebus 3 fertilibus, filamentis antheras aequantibus gracilibus, serierum I et II glabris, seriei III introrse pilosis basi biglandulosis; antheris oblongis obtusis; staminodiis ser. IV. sagittato-triangularibus glabris filamenta aequantibus; ovario glabro globoso stylum aequante; bacca carnosa globosa, basi perianthii lobis persistentibus circumdata.

Tree 5–10 meters high; branches and branchlets subterete, lightly striate, fuscous or stramineous, when young pulverulent with minute pale hairs, becoming glabrous; petioles shallowly canaliculate, 6–10 mm. long, slender, narrowly winged distally, puberulous (hairs minute, pale, less than 0.2 mm. long); leaf-blades ovate-oblong, 8–12 cm. long, 2.5–4 cm. broad, cuneate at base, bluntly short-acuminate at apex, entire and slightly thickened at margins, chartaceous, yellowish green, essentially glabrous above, pilose beneath (hairs pale, spreading, about 0.1 mm. long, slightly longer in nerve axils, persistent on our specimen), venation pinnate, secondary nerves 3 or 4 per side, arcuate-ascending, with the midnerve plane above, raised beneath, pale, conspicuous, veinlets reticulate, plane above, prominulous beneath; inflorescence panicled, axillary, 5–12 cm. long, 2- or 3-times branched, many-flowered (probably 25–100-flowered); rachis and branches stramineous, minutely puberulous, primary branches 1–4 cm. long; flowers greenish yellow, sparsely pale puberulous without, short-pedicellate (pedicels 2–3 mm. long); perianth tube broadly obconical, 1–1.5 mm. long, lobes 6, equal, slightly imbricate, ovate-oblong, about 2.1 mm. long and 1.5 mm. broad; fertile stamens 9, in three series, all with 4-locular anthers, first and second series with slender glabrous filaments about 0.9 mm. long and oblong anthers 0.9 mm. long and 0.5 mm. broad, anthers obtuse at apex, opening introrsely, third series with slender introrsely pilose (hairs reddish brown, about 0.15 mm. long) biglandular (glands cordate, orbicular, sessile, 0.5 mm. in diameter, attached slightly above base) filaments about 1.2 mm. long and oblong extrorsely dehiscent anthers 0.9 mm. long and 0.4 mm. broad; staminodes of fourth series sagittate-triangular, glabrous, 0.5 mm. long, 0.6 mm. broad, with filaments about the same length; ovary glabrous, globose, about 1.4 mm. in diameter at anthesis, style about 1 mm. long, stigma truncate; fruit carnose, globose, up to 4 mm. in diameter, surrounded at base by persistent perianth lobes.

Type, *KS 25430*, collected June 28, 1929, in dense forest, Kilometer 3–10, on Pichis Trail, dept. Junín, Peru, alt. 900 m., and deposited in the herbarium of the New York Botanical Garden. It is a species very closely related to *P. Brasiliensis* Mez, from which it differs by its somewhat narrower leaves with conspicuously pale nerves. In floral characters the two species are almost identical; however, the present species has staminodes about half as large as those of *P. Brasiliensis* and rather less conspicuous glands on the filaments of the third staminal series.

OCOTEA ACIPHYLLA (Nees) Mez. Peru—Loreto: Mishuyacu, *Klug 891*. Previously known from Amazonian Brazil.

Ocotea Keriana sp. nov. Arbor ca. 9 metralis; ramulis teretibus olivaceis vel nigrescentibus parce decidue tomentellis; petiolis leviter canaliculatis gracilibus nigrescentibus subrugosis glabris; laminis oblongo-ovatis vel oblongo-lanceolatis chartaceis olivaceis glabris, basi cuneato-attenuatis, apice

obtuse longe-acuminatis, nervo medio elevato, nervis lateralibus arcuato-adscendentibus; inflorescentia paniculata multiflora gracile minute tomentella; floribus hermaphroditis graciliter pedicellatis extus strigosis intus minute tomentellis, perianthii tubo obconico rugoso, lobis oblongo-ovatis subacutis, 3 exterioribus angustioribus; androecei seriebus 3 fertilibus, filamentis brevibus, seriei III basi biglandulosis; antheris oblongis apice truncatis; ovario subgloboso glabro stylum aequante.

Tree 6–9 meters high; branchlets terete, olivaceous or nigrescent, sparsely and minutely tomentellous when young, soon glabrous; petioles shallowly canaliculate, 6–11 mm. long, slender, nigrescent, subrugose, glabrous; leaf-blades oblong-ovate or ovate-lanceolate, 11–17 cm. long, 3.5–5.5 cm. broad, cuneate-attenuate at base, obtusely long-acuminate at apex, entire at margins, chartaceous, olivaceous, glabrous on both surfaces or minutely tomentellous on nerves beneath, pinnate-veined, secondary nerves 5 or 6 per side, arcuate-ascending, with the midnerve raised on both surfaces, veinlets prominulous-reticulate; inflorescence panicled, 8–14 cm. long, 4–8 cm. broad, 2- or 3-times branched, 100–200-flowered, branches of inflorescence slender, terete, minutely tomentellous (especially on young parts) with pale appressed hairs about 0.1 mm. long, lateral branches horizontal, up to 4 cm. long; flowers hermaphrodite, pale yellow, solitary or in clusters of 2 or 3, pedicellate (pedicels slender, 1–3 mm. long, minutely strigose with pale hairs about 0.1 mm. long, minutely deciduously bracteolate at base), short-strigose without, minutely tomentellous within, 2.5–3 mm. long at maturity; perianth tube obconical, rugose, about 1 mm. long, lobes 6, slightly imbricate, oblong-ovate, subacute, about 1.8 mm. long, the 3 exterior 1 mm. broad, the 3 interior 1.5 mm. broad; stamens 9, all fertile with 4-locular anthers; first and second series: filaments glabrous, 0.25 mm. long, eglandular, anthers 0.9 mm. by 0.5 mm., truncate at apex, locules introrse; third series: filaments glabrous, 0.3 mm. long, biglandular at base (glands subnigrescent, subglobose, 0.3 mm. in diameter, subsessile or with minute stalks 0.1 mm. long), anthers oblong, 0.8 mm. by 0.5 mm., locules extrorse; ovary subglobose, about 0.8 mm. in diameter at anthesis, glabrous; style as long as or slightly longer than ovary, stigma subcapitate.

Type, *KS 27111*, collected Aug. 5, 1929, in woods at Iquitos, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species related to *O. fasciculata* (Nees) Mez, from which it differs by its larger leaves and longer inflorescence, smaller floral glands, and lack of staminodes. From *O. minutiflora* O. C. Schmidt, another ally, it differs in leaf shape and size and in its larger flowers and long style. The species is dedicated to Mr. Graham Ker of Iquitos, whose hospitality and advice were much appreciated by the collectors.

Ocotea olivacea sp. nov. Arbor ca. 15 metralis; ramulis sulcato-angulatis fuscis glabris; petiolis canaliculatis crassis glabris; laminis oblongis vel oblongo-ellipticis, chartaceis vel subcoriaceis, olivaceis, utrinque glabris, basi

abrupte cuneatis, apice longe acuminatis, nervo medio supra elevato subtus prominente, nervis lateralibus arcuato-adscendentibus; inflorescentia paniculata multiflora glabra; floribus hermaphroditis albis pedicellatis extus glabris intus minute tomentellis, perianthii tubo late obconico breve, lobis oblongo-ovatis; androecei seriebus 3 fertilibus, filamentis quam antheris brevioribus glabris, seriei III basi biglandulosis; antheris ovoideis vel oblongis; ovario ellipsoideo glabro stylum aequante.

Tree 10–15 meters high; branchlets sulcate-angled, fuscous, glabrous; petioles canaliculate, 3–6 mm. long, stout (1.5–3 mm. in diameter), glabrous; leaf-blades oblong or elliptic-oblong, 25–28 cm. long, 8.5–9.5 cm. broad, abruptly cuneate at base, long-acuminate at apex, narrowly cartilaginous at margins, chartaceous or subcoriaceous, olivaceous, glabrous on both surfaces, pinnate-veined, midnerve raised above, prominent beneath, secondary nerves 8–11 per side, arcuate-ascending, slightly raised on both surfaces, veinlets reticulate, subimmersed, inflorescence panicled, 4–7 cm. long, 2- or 3-times branched, about 100-flowered, branches of inflorescence rugose, glabrous, primary branches 3–20 mm. long; flowers hermaphrodite, white, in clusters of 2 or 3, pedicellate (pedicels glabrous, 1–3 mm. long, deciduously minutely bracteolate at base), about 3 mm. in diameter when mature; perianth tube broadly obconical, less than 1 mm. long, lobes 6, slightly imbricate, glabrous without, minutely white-tomentellous within and at margins, oblong-ovate, subacute, about 2 mm. long and 1.4 mm. broad; stamens 9, all fertile with 4-locular anthers; first and second series: filaments glabrous, 0.25–0.4 mm. long, eglandular, anthers oblong, about 0.6 mm. long and 0.5 mm. broad, obtuse at apex, locules introrse; third series: filaments glabrous, about 0.4 mm. long, each with 2 subsessile cordate-based glands about 0.5 mm. in diameter, anthers ovoid, about 0.6 mm. in diameter, locules extrorse-lateral; ovary ellipsoid, about 0.8 mm. long at anthesis, glabrous, style as long as ovary, stigma truncate.

Type, *KS 29843*, collected Sept. 26, 1929, in woods at Iquitos, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species allied to *O. fasciculata* (Nees) Mez and *O. minutiflora* O. C. Schmidt, from both of which it differs by its larger short-petioled leaves, its glabrous inflorescence, and its glabrous filaments. From the former it also differs by its shorter pedicels and lack of staminodes, from the latter by its larger flowers.

Ocotea maynensis (Meissn.) Mez. Peru—Loreto: Mishuyacu, *Klug 883, 895, 943;* Balsapuerto, lower Río Huallaga basin, *KS 28390, 28401, 28597, 28604.* The last cited collections are from approximately the type locality; apparently it is not a rare species.

Ocotea opifera Mart. Brazil—Amazonas: Manáos, *KS 30071, 30134.* Probably fairly common in Amazonian Brazil.

OCOTEA DIELSIANA O. C. Schmidt. PERU—Loreto: Mishuyacu, *Klug 802, 991.* Collections from near the type locality.

Ocotea licanioides sp. nov. Arbor ca. 3 metralis; ramulis subteretibus dense fusco-tomentosis; petiolis subteretibus crassis tomentosis modo ramulorum; laminis oblongis coriaceis fuscescentibus, basi truncatis vel late cuneatis, apice subacutis (?), supra glabris vel dense pilosis ad nervos et paginam juvenilem, subtus persistenter villosis, nervo medio prominente, nervis lateralibus arcuato-adscendentibus supra planis subtus elevatis; inflorescentia ♂ graciliter paniculata multiflora dense fusco-villosa; bracteolis ovatis dense hirsutis deciduis; floribus ♂ breviter pedicellatis extus dense pilosis, perianthii deciduis; floribus ♂ breviter pedicellatis extus dense pilosis, perianthii tubo brevissimo, lobis ovatis, subacutis intus glabris vel basi breviter pilosis; androecei sereibus 3 fertilibus, filamentis glabris quam antheris brevioribus, seriei III basi biglandulosis; antheris oblongis apice truncatis vel leviter emarginatis; seriebus IV gynaeceoque defectis.

Tree about 3 meters high with drooping branches; branchlets subterete, densely fuscous-tomentose (hairs 1–2 mm. long, persistent); petioles subterete, 5–8 mm. long, stout (3–4 mm. in diameter), densely tomentose like the branchlets; leaf-blades oblong, 20–25 cm. long, 8–10 cm. broad, truncate or broadly cuneate at base, subacute (?) at apex, entire and slightly revolute at margins, thick coriaceous, fuscescent, above densely pilose on nerves and young surface (hairs about 1 mm. long), becoming glabrous, beneath uniformly villose with spreading hairs, pinnate-nerved, midnerve prominent on both surfaces, secondary nerves 10–12 per side, arcuate-ascending, nearly plane above, raised beneath, veinlets copiously reticulate, immersed above, raised beneath; ♂ inflorescence slenderly panicled, up to 7 cm. long on our specimen, once- or twice-branched, many-flowered, branches of inflorescence subterete, densely fuscous-villose, primary branches not more than 1 cm. long; bractlets ovate, densely hirsute, soon deciduous; flowers in clusters of 2–4, pedicellate (pedicels 1 mm. long or less, densely hirsute), densely pilose without (hairs appressed, about 0.3 mm. long); perianth tube small, not more than 0.5 mm. long, lobes 6, narrowly imbricate, subequal, ovate, subacute, about 2.5 mm. long and 1.8 mm. broad, glabrous within or short-pilose towards base; stamens 9, all fertile with 4-locular anthers; first and second series: filaments glabrous, slightly contracted, about 0.4 mm. long, eglandular, anthers oblong, about 0.9 mm. long and broad, truncate or lightly emarginate at apex, locules introrse; third series: filaments glabrous, about 0.5 mm. long, each with 2 subspherical sessile glands about 0.5 mm. in diameter; anthers oblong, about 0.8 mm. long and 0.7 mm. broad, lightly emarginate at apex, lower locules extrorse-lateral, upper locules lateral; fourth series and gynecium completely lacking.

Type, *Klug 1506*, collected May-June, 1930, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. It is a species related to *O. umbrosa* Mart., from which

it differs by its oblong leaves, shorter and glabrous filaments, and complete lack of a gynecium in the ♂ flowers, as well as in details of pubescence and dimensions.

OCOTEA LAXIFLORA (Meissn.) Mez. PERU—Loreto: Mishuyacu, *Klug 1486*. Our specimen has leaves larger than typical material of the wide-spread species, but is otherwise identical. The largest leaves are about 17 cm. long.

Ocotea Killipii sp. nov. Arbor ca. 9 metralis; ramis ramulisque gracilibus striatis decidue pilosis; petiolis leviter canaliculatis gracilibus subrugosis decidue pilosis; laminis ovato-oblongis chartaceis vel subcoriaceis, basi cuneatis, apice obtuse acuminatis, supra glabris, subtus decidue pilosis, nervo medio elevato, nervis lateralibus arcuato-adscendentibus; inflorescentia ♂ paniculata flexuosa multiflora subglabra subrugosa; floribus ♂ glabris breviter pedicellatis, perianthii tubo obconico breve, lobis ovato-oblongis, 3 exterioribus latioribus; androecei seriebus 3 fertilibus, serierum I et II filamentis brevissimis, seriei III filamentis antheras prope aequantibus; antheris oblongis apice truncatis; seriebus IV gynaeceoque defectis.

Tree 6–9 meters high with rounded crown; branches and branchlets dark brown, slender, striate, when young pilose (hairs pale, spreading, about 0.2 mm. long), becoming glabrous and nitid; petioles shallowly canaliculate, 7–15 mm. long, slender (1–1.5 mm. in diameter), subrugose, narrowly winged distally, deciduously pilose like the branchlets; leaf-blades ovate-oblong, 10–16 cm. long, 3.5–6.5 cm. broad, cuneate at base, bluntly acuminate at apex, entire and narrowly cartilaginous at margins, chartaceous when young, becoming subcoriaceous, dull green above, paler beneath, essentially glabrous above, when young pilose beneath (hairs pale, suberect, up to 0.3 mm. long, most numerous on veinlets, soon deciduous), venation pinnate, midnerve slightly raised on both surfaces, secondary nerves 4 or 5 per side, arcuate-ascending, copiously anastomosing near margins, veinlets copiously reticulate (ultimate obvious reticulations less than 1 mm. apart); ♂ inflorescence panicled, somewhat flexuose, 3–8 cm. long, 2- or 3-times branched, many-flowered (on our specimen 25–100-flowered), rachis and branches slender, essentially glabrous, subrugose, primary branches 3–20 mm. long, secondary branches, if present, up to 4 mm. long; flowers glabrous, dark green, short-pedicellate (pedicels up to 1.5 mm. long), 2–2.3 mm. long when mature; perianth tube obconical, about 1 mm. long, lobes 6, slightly imbricate, thin-carnose, 1–1.3 mm. long, the 3 exterior about 0.9 mm. broad, the 3 interior about 0.7 mm. broad; stamens 9, all fertile with 4-locular anthers, first and second series 0.8 mm. long, 0.5 mm. broad, with subsessile blunt introrsely-opening anthers, alternating with 6 minute triangular glands (?) about 0.3 mm. long, third series about 1 mm. long, 0.5 mm. broad, with stout filaments nearly as long as the anthers, anthers, blunt, opening extrorsely, fourth series and gynecium completely lacking; ♀ inflorescence and fruit not seen.

Type, *KS 23648*, collected May 30, 1929, in dense woods along Río Pinedo, north of La Merced, dept. Junín, Peru, alt. 700–900 m., and deposited in the herbarium of the New York Botanical Garden. Another collection from Peru is: Loreto: Masisea, on Río Ucayali, alt. 275 m., *KS 26861*. It is a species closely related to *O. laxiflora* (Meissn.) Mez, from which it differs by its smaller flowers, shorter pedicels, rounded perianth lobes, and eglandular third series of stamens. It is also related to *O. aniboides* Mez, from which it differs by having the inferior anther locules obvious and the connective not produced. It may be close to *O. architectorum* Mez, not available to me, which has tomentellous inflorescence and larger flowers.

OCOTEA MAROWYNENSIS (Miq.) Mez. PERU—Loreto: Mishuyacu, *Klug 127*. Previously known from Guiana. Our specimen differs noticeably from typical material by having the leaves about twice as broad and somewhat more coriaceous. However, in flower structure and form of inflorescence it is identical with Guiana specimens. I am unable to find any differences of specific consequence, and note the present collection as a broad-leaved form.

NECTANDRA PULVERULENTA Nees. PERU—Loreto: Mishuyacu, *Klug 1450*. Also collected by Tessmann in this approximate locality.

NECTANDRA LUCIDA Nees. PERU—Loreto: Yurimaguas, lower Río Huallaga, *KS 27709*. Several species closely related to this have been recently described by Schmidt, but our specimen seems best placed in *N. lucida*.

NECTANDRA LAEVIS Mez. PERU—Junín: Cahuapanas, on Río Pichis, alt. 340 m., *KS 26744*. A shrub 1–2 meters high, forming small thickets in this locality. Probably not rare throughout the region.

Pleurothyrium densiflorum sp. nov. Arbor ca. 10 metralis; ramis ramulisque subteretibus nigrescentibus crassis decidue sparse et minute cinereo-pulverulentis; petiolis canaliculatis gracilibus rugosis nigrescentibus subglabris; laminis oblongis vel elliptico-oblongis chartaceis, basi cuneatis, apice subacutis vel obtusis, supra glabris subtus subglabris, nervo medio prominente, nervis lateralibus patulis rectis adscendentibus ad marginem; inflorescentia paniculata multiflora minute cinereo-puberula; floribus hermaphroditis graciliter pedicellatis extus minute puberulis, perianthii tubo breve obconico, lobis oblongis apice rotundatis; androecei seriebus 3 fertilibus, filamentis quam antheris paullo brevioribus basi biglandulosis (glandulis magnis confluentibus); antheris oblongis vel subglobosis apice leviter emarginatis; ovario ellipsoideo rugoso quam stylo longiore.

Tree 8-10 meters high; branches and branchlets subterete, nigrescent, stout, when young sparsely and minutely cinereous-pulverulent, becoming

glabrous; petioles canaliculate, 7–15 mm. long, slender (1–2 mm. in diameter), rugose, nigrescent, essentially glabrous; leaf-blades oblong or elliptic-oblong, 13–18 cm. long, 4.5–6.5 cm. broad, cuneate at base, subacute or blunt at apex, entire and slightly recurved at margins, chartaceous, dull green, glabrous above, essentially glabrous beneath, venation pinnate, midnerve prominent on both surfaces, secondary nerves 10–14 per side, spreading, straight, ascending near margins, plane above, raised beneath, veinlets copiously reticulate; inflorescence panicled, copious from branchlets near apices, 4–6 cm. long, 2- or 3-times branched, many-flowered (probably 60–150-flowered), branches straight, striate, minutely cinereous-puberulous (hairs less than 0.05 mm. long, appressed, sparse), primary branches 3–5 mm. long; flowers hermaphrodite, yellow-green, 3–5 mm. in diameter, pedicellate (pedicels 3–6 mm. long), minutely cinereous-puberulous without; perianth tube obconical, about 1.3 mm. long, lobes 6, slightly imbricate, oblong, rounded at apex, about 2.5 mm. long and 1.5 mm. broad, slightly thickened at margins; stamens 9, all fertile with 4-locular anthers; first and second series: filaments 0.4–0.5 mm. long, anthers oblong, lightly emarginate at apex, 0.65 mm. long, 0.5 mm. broad, upper locules introrse-lateral, lower locules extrorse-lateral, glands 2 at base of each filament, forming with those of the next filament a confluent triangular mass about 0.8 mm. long and broad; third series: filaments stout, 0.4 mm. long, anthers subglobose, emarginate at apex, 0.5–0.6 mm. in diameter, upper locules introrse-lateral, lower locules extrorse, glands large, confluent with those of the outer series; ovary ellipsoid, rugose, about 1 mm. long and 0.6 mm. in diameter at anthesis, style about 0.5 mm. long, stigma truncate.

Type, *Klug 1372*, collected May–June, 1930, in forest at Mishuyacu, dept. Loreto, Peru, and deposited in the herbarium of the New York Botanical Garden. Another collection from the same locality is *Klug 1301*. It is a species most closely allied to *P. Poeppigii* Nees, from which it differs by its glabrous leaves with shorter petioles, its minutely gray-puberulous rather than ferruginous-tomentellous inflorescence, and its smaller flowers (about half as large) with oblong rounded rather than sublanceolate acute perianth lobes. From *P. chrysophyllum* Nees our species differs by its longer pedicels and filaments as well as by foliage characters.

NEW YORK BOTANICAL GARDEN

INDEX TO AMERICAN BOTANICAL LITERATURE

1929–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Addoms, R. M., Nightingale, G. T., & Blake, M. A. Development and ripening of peaches as correlated with physical characteristics, chemical composition, and histological structure of the fruit flesh: II. Histology and microchemistry. New Jersey Agr. Exp. Sta. Bull. 507: 1–19. *pl. 1, 2.* S 1930.

Ames, O., & Schweinfurth, C. New or noteworthy orchids. Sched. Orchid. **10:** 1–116. 1930.

Ames, O., & Schweinfurth, C. A new species of *Pleurothallis* from Mexico. Proc. Biol. Soc. Washington **43:** 195–196. 6 D 1930.

Arnold, C. A. Bark structure of *Callixylon*. Bot. Gaz. **90:** 427–431. *f. 1–6.* 27 D 1930.

Arnold, C. A. A petrified lepidophyte cone from the Pennsylvanian of Michigan. Am. Jour. Bot. **17:** 1028–1032. *f. 1–3.* "D 1930" 8 Ja 1931.

Artschwager, E. A comparative study of the stem epidermis of certain sugarcane varieties. Jour. Agr. Res. **41:** 853–865. *pl. 1+f. 1–9.* 15 D 1930.

Avery, P. Cytological studies of five interspecific hybrids of *Crepis leontodontoides*. Univ. California Publ. Agr. Sci. **6:** 135–167. *f. 1–18.* 10 D 1930.

Bailey, L. H. The cultivated Brassicas. II. Gentes Herbarum **2:** 211–267. *f. 108–146.* 6 D 1930.

Bailey, L. H. Various botanical and horticultural problems. Gentes Herbarum **2:** 159–206. f. 87–107. O 1930.

Includes 7. Several arrangements of names necessitated by recent studies. 8. Three discussions in Cucurbitaceae. 9. Binomials of certain palms. 10. South American novelties.

Benedict, R. C. A laboratory lesson in variation. Torreya **30:** 145–152. *f. 1–3.* D 1930.

Berger, F. *Neomammillaria* from Arizona. Desert **2:** 107–108. *illust.* D 1930.

Berkeley, G. H. Studies in fruit diseases II. Diseases of plums and their control. Canada Dep. Agr. Pamph. 119: 1–12. *f. 1–4.* 1930; III. Diseases of the raspberry. Canada Dep. Agr. Pamph. 120: 1–23. *f. 1–12.* 1930.

Berry, E. W. A new Miocene *Cercis* from Idaho and Washington. Bull. Torrey Club **57:** 239–244. *pl. 9+f. 1.* "Ap 1930" 15 Ja 1931.

Blomquist, H. L. Archegonial plants of *Tortula pagorum* (Milde.) de Not. in North Carolina. Bryologist **33:** 41–43. *f. 1, 2.* Jl 1930.

Bödeker, F. *Coryphantha Zilziana* Böd. sp. n. Monats. Deutsch. Kakteen-Gesell. **2:** 233–234. *illust.* N 1930.

A plant from Mexico.

Bödeker, F. *Echinocactus Andreae* Böd. sp. n. Monats. Deutsch. Kakteen-Gesell. **2:** 210–213. *illust.* 0 1930.

Bökeker, F. *Mamillaria erectohamata* Böd. spec. nova. Monats. Deutsch. Kakteen-Gesell. **2:** 189–191. *illust.* S 1930.

From Mexico.

Bödeker, F. *Mamillaria Orcuttii* Böd. spec. nova. Monats. Deutsch. Kakteen-Gesell. **2:** 258–259. *illust.* D 1930.

A plant from Mexico.

Bowen, P. R. A maple leaf disease caused by *Cristulariella depraedens.* Connecticut Agr. Exp. Sta. Bull. 316: 625–647. *pl. 29–36.* Ap 1930.

Breazeale, J. F. Maintenance of moisture-equilibrium and nutrition of plants at and below the wilting percentage. Arizona Agr. Exp. Sta. Tech. Bull. 29: 137–177. *f. 1–14.* 15 Mr 1930.

Brewer, P. H., Kraybill, H. R., Samson, R. W., & Gardner, M. W. Purification and certain properties of the virus of typical tomato mosaic. Phytopathology **20:** 943–950. D 1930.

Brink, R. A. Some problems in the utilization of inbred strains of corn (*Zea Mays*). Am. Nat. **64:** 525–539. D 1930.

Britton, N. L. (Rosales) Krameriaceae. N. Am. Flora **23:** 195–200. 18 N 1930.

Includes descriptions of three new species.

Britton, N. L., & Rose, J. N. (Rosales) Caesalpiniaceae. N. Am. Flora **23:** 201–268. 18 N 1930; (conclusio) N. Am. Flora **23:** 269–349. 6 D 1930.

Twenty-five new genera and many new species are described.

Britton, N. L., & Wilson, P. Botany of Porto Rico and the Virgin Islands. Supplement to descriptive flora—Spermatophyta—Bibliography—Spermatophyta and Pteridophyta. Index to volume V and VI. Sci. Surv. Porto Rico & the Virgin Islands **6:** 523–663. 19 D 1930.

Broadway, W. E. *Cactus Caesiius* (Wendl.) Britton & Rose. Jour. Cactus & Succ. Soc. Am. **2:** 366. D 1930.

Brown, F. B. H. New Polynesian plants. Bernice P. Bishop Mus. Occ. Papers 9^4: 1–23. *f. 1–6.* S 1930.

Brown, J. G. Timber-rot in the pepper tree, *Schinus molle.* Arizona Agr. Exp. Sta. Bull. 132: 443–454. *pl. 1–8.* 15 My 1930.

Brown, N. E. Mesembs. Jour. Cactus & Succ. Soc. Am. **2:** 372–373. *illust.* D 1930.

Bryan, M. K. Studies on bacterial canker of tomato. Jour. Agr. Res. **41:** 825–851. *pl. 1+f. 1–18.* 15 D 1930.

Buchholz, J. T., & Blakeslee, A. F. Pollen tube growth and control of gametophytic selection in cocklebur, a 25-chromosome *Datura.* Bot. Gaz. **90:** 366–383. *f. 1–13.* 27 D 1930.

Busse, W. F., & Burnham, C. R. Some effects of low temperatures on seeds. Bot. Gaz. **90:** 399–411. *f. 1–3.* 27 D 1930.

Butler, A. F. The Manaca or Cohune palm of Central America. Gard. Chron. **88:** 339–340. *f. 131.* 25 O 1930.

Cain, S. A. An ecological study of the heath balds of the Great Smoky Mountains. Butler Univ. Bot. Stud. **1:** 177–208. *f. 1–4.* D 1930.

Cain, S. A., & Friesner, R. C. Certain aspects of the H-ion concentration of the soils of a central Indiana river bluff. Butler Univ. Bot. Stud. **1:** 172–175. O 1930.

Cain, S. A., Friesner, R. C., & Potzger, J. E. A comparison of strip and quadrat analyses of the woody plants on a central Indiana river bluff. Butler Univ. Bot. Stud. **1:** 157–171. O 1930.

Camus, A. A new *Arundinaria* from China. Jour. Arnold Arbor. **11:** 192, 193. O 1930.

Capinpin, J. M. Meiotic behavior of triploid Oenotheras. Am. Nat. **64:** 566–570. D 1930.

Castle, W. E. Genetics and Eugenics. i-x, 1–474. *f. 1–170.* Cambridge, Mass., Harvard Univ. Press, 1930.

A text book for students of biology and a reference book for animal and plant breeders.

Castle, W. E. The significance of sexuality. Am. Nat. **64:** 481–494. D 1930.

Caum, E. L. New Hawaiian plants. Bernice P. Bishop Mus. Occ. Papers **9**[5]: 1–30. *pl. 1–15*+*f. 1, 2.* S 1930.

Caum, E. L. Notes on the flora of Molokini. Bernice P. Bishop Mus. Occ. Papers **9**[1]: 15–18. 1930.

Chardon, C. E. New or interesting tropical American Dothideales. II. Jour. Dep. Agr. Porto Rico **13**: 3–15. *pl. 1, 2.* Ja 1929.

Chester, K. S. Graft-blight of lilac. Jour. Arnold Arbor. **11**: 232, 233. O 1930.

Ciferri, R. Morphological relations of the genera of asporigenous yeasts. Ann. Myc. **28**: 372–376. 1930.

Clos, E. C., & Lahitte, R. Arboles y arbustos cultivados en la Argentina III. (Leguminosae—Caesalpinioideae). Bol. Min. Agr. Rep. Argentina **29**: 239–266. *pl. 1–7*+*f. 1–35.* S 1930.

Clute, W. N. The meaning of plant names XLIII. Cone-flowers and fleabanes. Am. Bot. **36**: 129–133. Jl 1930; XLIV. Autumn composites. 186–192. O 1930; XLV. Certain weedy composites. Am. Bot. **37**: 7–12. Ja 1931.

Coker, W. C. The bald cypress. Jour. Elisha Mitchell Sci. Soc. **46**: 86–88. *pl. 7.* N 1930.

Coker, W. C. Notes on fungi, with a description of a new species of *Ditiola*. Jour. Elisha Mitchell Sci. Soc. **46**: 117–120. *pl. 8, 9.* N 1930.

Collins, G. N. The phylogeny of maize. Bull. Torrey Club **57**: 199–210. "Ap 1930" 15 Ja 1931.

Cook, M. T. Distribución geográfica de las enfermedades de la caña de azucar. Rev. Agr. Puerto Rico **25**: 170–172. N 1930.

Cooper, H. P., & Wilson, J. K. Relation of ash constituents of pasture plants to the oxidation-reduction potentials of nutrients. Soil Sci. **30**: 421–430. D 1930.

Copeland, E. B. New or interesting Philippine ferns, VII. Philippine Jour. Sci. **40**: 291–315. *pl. 1–9.* N 1929.

Copeland, H. F. Philippine Ericaceae I. The species of *Rhododendron*. Philippine Jour. Sci. **40**: 133–179. *pl. 1–16.* O 1929.

Couch, J. N. A monograph of *Septobasidium*. Part I. Jamaican species. Jour. Elisha Mitchell Sci. Soc. **44**: 242–260. *pl. 10–25.* Ap 1929.

Diehl, W. W. Conidial fructifications in *Balansia* and *Dothichloe*. Jour. Agr. Res. **41**: 761–766. *pl. 1, 2*+*f. 1–3.* 1 D 1930.

Dillon Weston, W. A. R., & Halnan, E. T. The fungicidal action of ultra-violet radiation. Phytopathology **20**: 959–965. *f. 1, 2.* D 1930.

Dorf, E. Pliocene floras of California. Carnegie Inst. Washington Publ. 412: 1–112. *pl. 1–13.* O 1930.

Durrell, L. W. The pathology of maize. Bull. Torrey Club **57:** 233–237. "Ap 1930" 15 Ja 1931.

Durst, C. E. Inheritance in lettuce. Illinois Agr. Exp. Sta. Bull. 356: 239–341. *f. 1–3.* O 1930.

Eaton, F. M. The effect of boron on powdery mildew and spot blotch of barley. Phytopathology **20:** 967–972. *f. 1.* D 1930.

Eggleston, W. W., Black, O. F., & Kelley, J. W. *Linum neomexicanum* (yellow pine flax) and one of its poisonous constituents. Jour. Agr. Res. **41:** 715–718. *f. 1.* 15 N 1930.

Ekman, E. L. A list of plants from the Island of Gonave, Haiti. Ark. Bot. **23A**[6]**:** 1–73. 20 Jl 1930.

Emerson, S. The inheritance of Rubricalyx bud color in crosses with *Oenothera Lamarckiana.* Proc. Nat. Acad. Sci. **16:** 796–800. D 1930.

Ever, S. J. Notes on Katahdin plants. Rhodora **32:** 259–261. 18 D 1930.

Evans, M. M., & Harrar, G. Germination of the oospores of *Sclerospora graminicola* (Sacc.) Schroet. Phytopathology **20:** 993–997. *f. 1, 2.* D 1930.

Farwell, O. A. *Aira spicata,* Linn. and the application of the international rules. Rhodora **32:** 261–263. 18 D 1930.

Felippone, F. Plantas Uruguayas clasificadas en "Kew Gardens." Darwiniana **2:** 71–79. 31 D 1930.

Fenstel, I. C., & Byers, H. G. The physical and chemical characteristics of certain American peat profiles. U. S. Dep. Agr. Tech. Bull. 214: 1–26. *f. 1, 2.* N 1930.

Flowers, S. *Pottia Randii* Kennedy. Bryologist **33:** 30. "My 1930" 7 Ja 1931.

Frear, D. E. The classification of plant juices: nitrate concentration in large and small leaves. Science II. **72:** 634–635. 19 D 1930.

Frick, G. A. *Euphorbia clava.* Jour. Cactus & Succ. Soc. Am. **2:** 375–376. *illust.* D 1930.

Frost, F. H. Histology of the wood of angiosperms I. The nature of the pitting between tracheary and parenchymatous elements. Bull. Torrey Club **56:** 259–264. *pl. 10.* "My" 15 Jl 1929.

Garner, W. W., & Allard, H. A. Photoperiodic response of soybeans in relation to temperature and other environmental factors. Jour. Agr. Res. **41:** 719–735. *f. 1–4.* 15 N 1930.

Gillespie, J. W. New plants from Fiji—I. Bernice P. Bishop Mus. Bull. **74:** 1–99. *f. 1–57.* 1930.

Goldring, W. The oldest known petrified forest. Am. For. & For. Life **36**: 491–493, 546–547. Au 1930.

Gravatt, G. F., & Gill, L. S. Chestnut blight. U. S. Dep. Agr. Farm. Bull. 1641: 1–18. *f. 1–15*. N 1930.

Graves, A. H. Forms and functions of roots. Brooklyn Bot. Gard. Leafl. 18: 1–8. *f. 1, 2*. 17 D 1930.

Grimsley, G. Some observations on *Tilia* (basswood) seeds. Jour. Elisha Mitchell Sci. Soc. **46**: 72–73. N 1930.

Groh, H. Grand Prairie weeds—a provisional review. Canada Dep. Agr. Pamph. 117: 1–12. 1930.

Groh, H. Horsetail a horse-poisoning weed. Ottawa Exp. Farm. Circ. 74: 1–3. *illust.* 1930.

Grout, A. J. A fossil form of *Drepanocladus fluitans Jeanbernati* (Ren.) Grout. Bryologist **33**: 33. "My 1930" 7 Ja 1931.

Grout, A. J. A new species of *Rhynchostegiella* from the southern United States. Bryologist **33**: 27. *pl. 4*. "My 1930" 7 Ja 1931.

Guba, E. F. Monograph of the genus *Pestalotia* de Notaris. Part I. Phytopathology **19**: 191–232. *pl. 4+f. 1–7*. Mr 1929.

Gustafson, F. G. Intramolecular respiration of tomato fruits. Am. Jour. Bot. **17**: 1011–1027. *f. 1–11*. "D 1930" 8 Ja 1931.

Guthrie, J. D. An iodimetric method for determining oxidase acidity. Jour. Am. Chem. Soc. **52**: 3614–3618. *f. 1, 2*. 1930.

Hall, E. H. A partial check list of the ferns found in the Mountain Park and Roaring Gap region. Jour Elisha Mitchell Sci. Soc. **46**: 69–71. N 1930.

Hanna, W. F., & Popp, W. Relationship of the oat smuts. Nature **126**: 843–844. 29 N 1930.

Harris, J. A., & Pascoe, T. A. Further studies on the relationship between the concentration of the soil solution and physicochemical properties of the leaf-tissue fluids of cotton. Jour. Agr. Res. **41**: 767–788. *f. 1–5*. 1 D 1930.

Harrison, T. G. *Polycodium Ashei*, a new deerberry from the southeast. Am. Midl. Nat. **12**: 179–181. N 1930.

Hawthorne, W. C. Diffusion, osmosis and osmotic pressure. Sci. Monthly **31**: 535–542. D 1930.

Heaton, F *Gladiolus* breeding. Gladiolus Rev. **7**: 390–391, 423. N 1930.

Heilborn, O. On some species of *Tropaeolum* from Ecuador. Ark. Bot. **23A⁹**: 1–10. *f. 1–4*. 2 S 1930.

Three new species are described.

Heilborn, O. Section Fruticosae Eichl. of the genus *Cleome* L. Ark. Bot. **23A¹⁰**: 1–19. *f. 1–6*. 26 S 1930.

Describes seven new species from South America.

Hicken, C. M. Primitiae Sanzinianae. Las premeras plantas recogidas en Mendoza por Renato Sanzin. Darwiniana **2:** 37–79. 31 D 1930.

Higgins, B. B. Morphology and life history of some Ascomycetes with special reference to the presence and function of spermatia. II. Am. Jour. Bot. **16:** 287–296. *pl. 22+f. 1.* My 1929.

Hitchcock, A. S. A botanical trip to south and east Africa. Sci. Monthly **31:** 481–507. *illust.* D 1930.

Hitchcock, A. S. The relation of grasses to man. So. African Jour. Sci. **26:** 133–138. D 1929.

Hollick, A. One thousand miles down the Yukon by canoe. Jour. N. Y. Bot. Gard. **31:** 292–296. D 1930.

Hollingshead, L. A cytological study of haploid *Crepis capillaris* plants. Univ. California Publ. Agr. Sci. **6:** 107–134. *pl. 6–8+f. 1–13.* 25 N 1930.

Holman, R. On solarization of leaves. Univ. California Publ. Bot. **16:** 139–151. *f. 1–7.* 12 D 1930.

Hopkins, E. F. The necessity and function of manganese in the growth of *Chlorella* sp. Science II. **72:** 609–610. 12 D 1930.

Hu, H. H. Notulae systematicae ad floram Sinensem. II. Jour. Arnold Arbor. **11:** 224–228. O 1930.

Huber, G. A. The *Aspergilli* and their relation to decay in apples. Jour. Agr. Res. **41:** 801–817. *f. 1–17.* 1 D 1930.

Huelsen, W. A., & Gillis, M. C. Breeding two new varieties of greenhouse tomatoes resistant to *Fusarium* wilt. Illinois Agr. Exp. Sta. Bull. 361: 409–434. *f. 1–8.* D 1930.

Humphrey, H. B., & Cromwell, R. O. Stripe rust, *Puccinia glumarum*, on wheat in Argentina. Phytopathology **20:** 981–986. D 1930.

Ilvessalo, Y. Notes on some forest (site) types in North America. Acta Forest. Fennica **34:** 1–111. *f. 1–38.* 1930.

Jacques, A. G., & Osterhout, W. J. V. The accumulation of electrolytes. III. Behavior of sodium, potassium and ammonium in *Valonia.* Jour. Gen. Physiol. **14:** 301–314. *f. 1–3.* 20 N 1930.

Johansen, D. A. Some evening primroses: *Burragea.* Desert **2:** 103–104. *illust.* D 1930.

Judd, C. S. Chaulamoogra oil trees in Hawaii. Hawaiian For. & Agr. **27:** 105–106. S 1930.

Kearney, T. H. Genetics of cotton. Jour. Heredity **21:** 325–336. *f. 15–20.* Jl 1930; 375–384. *f. 7–10.* Au 1930.

Kelley, V. W. Effect of certain hydrocarbon oils on the transpiration rate of some deciduous tree fruits. Illinois Agr. Exp. Sta. Bull. 353: 581–600. Au 1930.

Kendall, J. A parthenogenetic aberrant tobacco plant. Jour. Heredity 21: 363–366. *f. 4–6.* Au 1930.

Killip, E. P., & Smith, A. C. The South American species of *Viburnum.* Bull. Torrey Club 57: 245–258. "Ap 1930" 15 Ja 1931.

Includes descriptions of three new species and several new combinations and forms.

Kilmer, F. B. The Daturas. Am. Jour. Pharm. 102: 526–534. S 1930.

King, C. J. Development of the axillary buds on fruiting branches of Pima and Upland cotton. Jour. Agr. Res. 41: 697–714. *f. 1–12.* 15 N 1930.

Knuth-Knuthenborg, F. M. Den nye Kaktusbog. 1–136. *f. 1–175.* Kopenhagen, 1930.

Kobel, F. Die verschiedenen Formen der Sterilität bei unseren Obstgewächsen. Viert. Natur. Gesell. 75: 56–160. *f. 1–13.* 30 Je 1930.

Kobuski, C. E. A supplement to J. T. P. Byhouwer, "An enumeration of the roses of Yunnan." Jour. Arnold Arbor. 11: 228–231. O 1930.

Koch, F. In den Wäldern Guatemalas. Mitteil. Deutsch. Dendrol. Gesell. 42: 337–347. *pl. 51, 52.* 1930.

Koehler, B., & Holbert, J. R. Corn diseases in Illinois. Illinois Agr. Exp. Sta. Bull. 354: 1–164. *pl. 1–5+f. 1–71.* S 1930.

Knuth, R. Dioscoreaceae novae, Decas 3–5. Repert. Spec. Nov. 28: 81–93. 31 O 1930.

Many new species from South America are described.

Krajina, V. New Hawaiian species of *Pipturus.* Bernice P. Bishop Mus. Occ. Papers 9: 1–6. *pl. 1, 2.* 20 Ap 1930.

Kümmerle, J. B. Has the genus *Onychium* any representative in South America? Am. Fern Jour. 20: 129–138. *pl. 7, 8.* 26 D 1930.

Laguna, A. R. Contribucion para el conocimiento de los Agaves de Mexico. *Agave Karwinski* Zuccarini. An. Inst. Biol. Mexico 1: 313–317. *f. 1–4.* 1930.

Leon, Bro. Apports de la botanique à la geographie specialement dans les Grandes Antilles. Rev. Soc. Geogr. Cuba (1–11.) 1930.

Leonard, E. C. The genus *Trichanthera.* Jour. Washington Acad. Sci. 20: 484–488. *f. 1.* 4 D 1930.

Lepeschkin, W. W. Light and permeability of protoplasm. Am. Jour. Bot. **17**: 953–970. "D 1930" 8 Ja 1931.

Lindstrom, E. W. The genetics of maize. Bull. Torrey Club **57**: 221–232 *f. 1.* "Ap 1930" 15 Ja 1931.

Loesener, T. Zingiberacae novae vel minus cognitae II. Notizbl. Bot. Gart. Berlin **10**: 706–716. 10 Jl 1929.

Includes new South American species in *Cactus* (11) and *Dimerocactus* (1).

Loeske, L. Holzingers' No. 663 again. Bryologist **33**: 31–32. "My 1930" 7 Ja 1931.

Longley, A. E., & Clark, C. F. Chromosome behavior and pollen production in the potato Jour. Agr. Res. **41**: 867–888. *pl. 1, 2+f. 1–7.* 15 D 1930.

Looser, G. Apuntes estadisticos y geograficos sobre las Cactáceas y en especial sobre las de Argentina y Chile. Rev. Univ. Catholica Chili **15**: 372–397. Jl 1930.

Mac Daniels, L. H., & Curtis, O. F. The effect of spiral ringing on solute translocation and the structure of the regenerated tissues of the apple. Cornell Agr. Exp. Sta. Mem. 133: 1–31. *pl. 1–5+f. 1–11.* O 1930.

McIntosh, A. C. Biological features of Cascade Valley and vicinity. Black Hills Engineer **16**: 68–83. Ja 1928.

McIntosh, A. C. Botanical features of the northern Black Hills. Black Hills Engineer **18**: 1–31. *illust.* Ja 1930.

McKee, A. "Lily Pond lane" (a bit of Long Island ecology). Torreya **30**: 153–158. *illust.* D 1930.

McNair, J. B. Spices and condiments. Field Mus. Nat. Hist. Bot. Leafl. 15: 1–64. *illust.* 1930.

Malhotra, R. C. A new method of germination and the influence of hydrogen ion concentration on the germination and growth of *Helianthus annuus* and *Lycopersicum esculentum.* Jour. Indian Bot. Soc. **9**: 218–239. *pl. 1, 2+f. 1.* O 1930.

Malhotra, R. C. The sex ratio in *Asparagus officinalis* L. and its artificial modification. Jour. Genetics **23**: 157–172. *f. 1–5.* 28 N 1930.

Mann, F. J. Winter root development of *Ligustrum vulgare.* Jour. Elisha Mitchell Sci. Soc. **46**: 62–66. *pl. 5, 6.* N 1930.

Mansfeld, R. Orchideologische Mitteilungen I. Repert Spec. Nov. **28**: 93–96. 31 O 1930.

Describes three new species from Amazonas.

Marine, D., Baumann, E. J., & Webster, B. The relative amounts of iodine-absorbing (reducing) materials in various plants. Jour. Biol. Chem. **89**: 213–219. N 1930.

Marsh, C. D., & Clawson, A. B. Mountain-laurel (*Kalmia latifolia*) and sheep laurel (*Kalmia angustifolia*) as stock-poisoning plants. U. S. Dep. Agr. Tech. Bull. 219: 1–22. *f. 1–6.* D 1930.

Mathias, M. E. Studies in the Umbelliferae III. A monograph of *Cymopterus* including a critical study of related genera. Ann. Missouri Bot. Gard. **17**: 213–476. *pl. 21–51.* N 1930.

Melchior, H. Ein neues Veilchen (*Viola saccata* spec. nov.) Repert. Spec. Nov. **28**: 96–97. 31 O 1930.

Morton, F. Planta nova florae Guatemalensis collecta a Dr. F. Morton in itinere 1928–1929. Repert. Spec. Nov. **28**: 108–109. 31 O 1930.

Mulvania, M. New types of plants in Florida. Science II. **72**: 603–604. 12 D 1930.

Navashin, M. Studies on polyploidy I. Cytological investigations on triploidy in *Crepis*. Univ. California Publ. Agr. Sci. **2**: 377–400. *pl. 56, 57.* 6 Ap 1929.

Navez, A. E. Respiration and geotropism in *Vicia faba*. I. Jour. Gen. Physiol. **12**: 641–667. *f. 1–7.* 20 My 1929.

Newell, W., Mowry, H., & Barnette, R. M. The tung-oil tree. Florida Agr. Exp. Sta. Bull. 221: 1–63. *f. 1–33.* O 1930.

Nieves, R. Ensayos comparativos de resistencia a la "Tilletia laevis" (Kuhn.) con trigos Argentinos e importados comunes y de pedigree. Bol. Min. Agr. Rep. Argentina **29**: 297–316. S 1930.

O'Kelly, J. F., & Hull, W. W. Cotton inheritance studies. Lint percentage. Mississippi Agr. Exp. Sta. Tech. Bull. 18: 1–15. *f. 1–4.* S 1930.

Ostenfeld, C. H., & Larsen, C. S. The species of the genus *Larix* and their geographical distribution. Kgl. Dansk. Viden. Selskab Biol. Med. **9**: 1–106. *f. 1–35.* 1930.

Osterhout, W. J. V. The accumulation of electrolytes II. Suggestions as to the nature of accumulation in *Valonia*. Jour. Gen. Physiol. **14**: 285–300. 20 N 1930.

Owen, W. L., & Denson, W. P. The effect of plowing under cane trash upon the available nitrogen of the soil. Zentralb. Bakt. 2 Abt. **82**: 174–199. *f. 1–4.* 12 D 1930.

Palmer, E. J. Additional notes on Texas ferns. Am. Fern Jour. **20**: 138–142. 26 D 1930.

Pease, V. A. Notes on the histology of the almond. Jour. Agr. Res. **41**: 789–800. *f. 1–4.* 1 D 1930.

Pereira, C., & Vaz, Z. Nota sobre as variacoes dos raios da Bolsa caudal de Algunas "Strongyloidea." Arch. Inst. Biol. Sao Paulo **3**: 59–67. *f. 1–27.* 1930.

Perry, G. S. Another deadly disease of chestnut. Forest Leaves 22: 169. O 1930.

Petrak, F., & Ciferri, R. Fungi Dominicani. Ann. Myc. **28:** 377–420. 30 D 1930.

Thirty-eight new species in various genera are described.

Pitman, E. M., & Pitman, H. Mushrooms of Winthrop, and of South Portland, contrasted. Maine Nat. **10:** 23–28. Ap 1930.

Pitman, E. M., & Pitman, H. Some Maine grasses, and grass-like plants. Maine Nat. **10:** 74–76. 1930.

Pleasants, A. L. The effect of nitrate fertilizer on stomatal behavior. Jour. Elisha Mitchell Sci. Soc. **46:** 95–116. *f. 1–3.* N 1930.

Pope, W. T. Papaya culture in Hawaii. Hawaii Agr. Exp. Sta. Bull. 61: 1–40. *f. 1–30.* O 1930.

Porsild, M. P. Stray contributions to the flora of Greenland. I–V. Art. Danske Ark. Sta. Paa. Disko 13: 1–44. *f. 1–8.* 1930.

Potter, G. F., & others. Some effects of defoliation on fruit spur composition and fruit bud formation in the Oldenburg apple. N. Hampshire Agr. Exp. Sta. Tech. Bull. 41: 1–26. *f. 1–16.* Je 1930.

Read, C. B. Fossil floras of Yellowstone National Park I. Coniferous woods of Lamar River flora. Carnegie Inst. Publ. 416: 1–19. *pl. 1–6.* D 1930.

Reddick, D. Frost-tolerant and blight-resistant potatoes. Phytopathology **20:** 987–991. D 1930.

Reed, G. M. Report on a trip to Japan and to the northwestern United States. Brooklyn Bot. Gard. Rec. **19:** 257–268. *f. 1–7.* N 1930.

Reed, H. S. The swelling of *Citrus* fruits. Am. Jour. Bot. **17:** 971–982. *f. 1–6.* "D 1930" 8 Ja 1931.

Rehder, A. Ernest Henry Wilson. Jour. Arnold Arbor. **11:** 181–192. *portrait.* O 1930.

Reichert, I. Diseases new to *Citrus*, found in Palestine. Phytopathology **20:** 999–1002. *f. 1.* D 1930.

Reichert, I. The susceptibility of American wheat varieties resistant to *Tilletia Tritici*. Phytopathology **20:** 973–980. D 1930.

Reichert, I., & Fawcett, H. S. *Citrus* diseases new to Palestine. Phytopathology **20:** 1003. D 1930.

Reid, M. E. The influence of nutritive conditions of seeds and cuttings upon the development of roots. Gard. Chron. **88:** 392–393. 8 N 1930.

Rios Lavienna, G. Plantas leguminosas como Abonos verdes. Rev. Agr. Puerto Rico **25**: 188–193. *illust.* N 1930.

Riley, J. E. Jr. White pine blister rust control in Connecticut. Connecticut Agr. Exp. Sta. Bull. 314: 456–477. *f. 35–43.* Ap 1930.

Ritchie, J. W., & Echavarria, J. P. Philippine plant life. i-ix, 1–244. *f. 1–168.* New York, Silver Burdett & Co. 1930.

Robinson, B. L. Observations on the genus *Stevia.* Contr. Gray Herb. Harvard Univ. **90**: 36–58. 1 Au 1930.

Robinson, B. L. Records preliminary to a general treatment of the Eupatorieae. VIII. Contr. Gray Herb. Harvard Univ. **90**: 3–36. 1 Au 1930.

Robinson, B. L. The Stevias of North America. Contr. Gray Herb. Harvard Univ. **90**: 90–159. 1 Au 1930.

Robinson, B. L. The Stevias of the Argentine Republic. Contr. Gray Herb. Harvard Univ. **90**: 58–79. 1 Au 1930.

Robinson, B. L. The Stevias of Paraguay. Contr. Gray Herb. Harvard Univ. **90**: 79–90. 1 Au 1930.

Robitaille, A. L'abbe Ovide Brunet et le Musée de botanique de l'Université Laval. Nat. Canadien **57**: 250–254. D 1930.

Rodenhiser, H. A. Physiologic specialization and mutation in *Phlyctaena linicola* Speg. Phytopathology **20**: 931–942. *f. 1–4.* D 1930.

Sampson, A. W., & McCarty, E. C. The carbohydrate metabolism of *Stipa pulchra.* Hilgardia **5**: 61–100. *f. 1–16.* N 1930.

Sampson, A. W., & Parker, K. W. St. Johnswort on range lands of California. California Agr. Exp. Sta. Bull. 503: 1–48. *f. 1–23.* D 1930.

Samuels, M. C. *Echeveria scaphophylla.* Desert **2**: 117, 119. *illust.* Ja 1931.

Samuels, M. C. *Echeveria simulans.* Desert **2**: 108. *illust.* D 1930.

Sandwith, N. Y. Contributions to the flora of tropical America. II. *Chondodendron candicans,* a menispermaceous bush-rope of Guiana. Kew Bull. Misc. Inf. **1930**: 339–343. 1930; III. Annonaceae collected by the Oxford University Expedition to British Guiana, 1929. 466–480. 4 D 1930; IV and V, Kew Bull. Misc. Inf. **1931**: 46–61. 1931.

Sandwith, N. Y. *Magallana portifolia* Cav. Hooker's Icon. Plant. **2**: *pl. 3150.* Au 1930.

A plant from Argentine.

Sandwith, N. Y. *Viola coronifera,* W. Becker. Hooker's Icon. Plant. **2**: *pl. 3147*. Au 1930.

An Argentine plant.

Sandwith, N. Y. *Viola escondidäensis* W. Becker. Hooker's Icon. Plant. **2**: *pl. 3148*. Au 1930.

An Argentine plant.

Sandwith, N. Y. *Viola Hillii,* W. Becker. Hooker's Icon. Plant. **2**: *pl. 3149*. Au 1930.

A plant found in Peru and Bolivia.

Sax, H. J. Chromosome numbers in *Quercus*. Jour. Arnold Arbor. **11**: 220–223. O 1930.

Sax, K. Chromosome structure and the mechanism of crossing over. Jour. Arnold Arbor. **11**: 193–220. *pl. 25–26*. O 1930.

Scasso, J. M., & Millan, A. R. Ersayo de clasificacion de variedades de tomate experimentadas por la agronomia regional de Moron. Bol. Min. Agr. Rep. Argentina **29**: 267–296. *f. 1–7*. S 1930.

Seckt, H. Algenforschung in Argentinien. II. Ber. Deutsch. Bot. Gesell. **48**: 420–427. 29 D 1930.

Semmens, E. S. Hydrolysis in the living plant by polarized light. Bot. Gaz. **90**: 412–426. *f. 1–19*. 27 D 1930.

Sharp, A. J. Bryophytes of southeastern Oklahoma. I. A preliminary list with notes. Bryologist **33**: 45–55. "Jl 1930" Ja 1931.

Shear, C. L. Franklin Sumner Earle, 1856–1929. Phytopathology **20**: 923–929. *portrait*. D 1930.

Sherff, E. E. New or otherwise noteworthy Compositae V. Bot. Gaz. **90**: 384–398. *pl. 4, 5*. 27 D 1930.

Sherff, E. E. Studies in the genus *Bidens*—IX. Bot. Gaz. **86**: 435–447. *pl. 14–16*. 27 D 1928.

Sideris, C. P., & Paxton, G. E. Heart rot of pineapple plants. Phytopathology **20**: 951–958. *f. 1–4*. D 1930.

Sievers, A. F. American medicinal plants of commerical importance. U. S. Dep. Agr. Miscl. Publ. **77**: 1–74. *f. 1–128*. Jl 1930.

Simpson, C. T. The palms. Beaut. Florida **7**: 7–9, 13–14. *illust.* O 1930.

Sinnott, E. W., & Hammond, D. Factoral balance in the determination of fruit shape in *Cucurbita*. Am. Nat. **64**: 509–524. *f. 1–9*. D 1930.

Skutch, A. F. Unrolling of leaves of *Musa sapientum* and some related plants and their reactions to environmental aridity. Bot. Gaz. **90:** 337–365. *f. 1–23.* 27 D 1930.

Smith, C. M. Development of *Dionaea muscipula.* I. Flower and seed. Bot. Gaz. **87:** 507–530. *pl. 20–24*+*f. 1–3.* 22 My 1929.

Stadler, L. J. Recovery following genetic deficiency in maize. Proc. Nat. Acad. Sci. **16:** 714–720. N 1930.

Standley, P. C. Flora of Yucatan. Field Mus. Nat. Hist. Publ. Bot. **3:** 157–492. 11 S 1930.

Stapf, O. *Megaskepasma erythrochlamys,* Lindau. Hooker's Icon. Plant. **2:** *pl. 3128.* Au 1930.

A plant from Venezuela.

Starkey, R. L. Some influences of the development of higher plants upon microörganisms of the soil: III. Influence of the stage of plant growth upon some activities of the organisms. Soil Sci. **27:** 433–444. *f. 1–3.* Je 1929.

Stevens, F. L. The effects of ultra-violet irradiation on various Ascomycetes, Sphaeropsidales and Hyphomycetes. Zentralb. Bakt. 2 Abt. **82:** 161–174. *f. 1–17.* 12 D 1930.

Stevens, F. L. Parasitic fungi of British Guiana, Trinidad and Costa Rica. Ann. Myc. **28:** 364–371. *illust.* 30 D 1930.

Describes 4 new genera and 10 new species in various genera.

Stevens, F. L. Relation of nutrients to perithecial production under ultraviolet irradiation. Philippine Agr. **19:** 265–272. O 1930.

Stevens, F. L., & Ragle, M. E. The reaction between various races of *Sclerotium* and other fungi. Trans. Am. Micros. Soc. **49:** 264–268. *f. 1, 2.* Jl 1930.

Stout, A. B. Forestation with poplars in France. Jour. N. Y. Bot. Gard. **31:** 285–292. *f. 1–4.* D 1930.

Stout, A. B. Virus diseases of lilies in England. Gard. Chron. **88:** 532–533. 27 D 1930.

Styer, J. F. Nutrition of the cultivated mushroom. Am. Jour. Bot. **17:** 983–994. "D 1930" 8 Ja 1931.

Svenson, H. K. Report on a botanical trip to the Galapagos Islands. Brooklyn Bot. Gard. Rec. **19:** 269–284. *f. 8–13.* N 1930.

Svihla, R. D. Some mosses from southern Louisiana. Bryologist **33:** 29–30. "My 1930" 7 Ja 1931.

Tehon, L. R., & Stout, G. L. Notes on the parasitic fungi of Illinois—IV. Mycologia **21:** 180–196. *pl. 13.* 1 Jl 1929.

Three new genera and many new species are described.

Teuscher, H. *Cotoneaster*. Mitteil. Deutsch. Dendrol. Gesell. **42**: 24–30. 1930.

Thierot, I. Contributions a la flore bryologique du Chili. Rev. Chilena Hist. Nat. **34**: 258–262. *f. 49*. 1930.

Thomas, H. E. The longevity of *Bacillus amylovorus* (Burr.) Trev. in association with honey. Science II. **72**: 624. 19 D 1930.

Thomas, W. Studies of certain phases of the interrelationship between soil and plant.: I. Availability of mineral plant nutrients in relation to the degree of dispersion. Soil Sci. **27**: 249–270. Ap 1929.

Thornton, N. C. Carbon dioxide storage of fruits, vegetables and flowers. Ind. Engineer Chem. **22**: 1186–1189. N 1930.

Tyson, J. Influence of soil conditions, fertilizer treatments, and light intensity on growth, chemical composition, and enzymic activities of sugar beets. Michigan Agr. Exp. Sta. Tech. Bull. 108: 1–44. *f. 1–4*. O 1930.

Uphof, J. C. Dendrologische Notizen aus dem Staate Florida. V. Biologische und morphologische Bechachtungen über verschiedene Pflanzen-Gesellschaften. Mitteil. Deutsch. Dendrol. Gesell. **42**: 105–126. *pl. 15, 16*. 1930.

Urban, I. Plantae Haitienses et Domingenses novae vel rariores. VIII. a cl. E. L. Ekman 1924–1928 lectae. Ark. Bot. **21** A^5: 1–107. *pl. 1–5*. 29 Jl 1930.

Urban, I. Sertum antillanum XXIX. Repert. Spec. Nov. **26**: 97–118. 31 My 1929; XXX. Repert. Spec. Nov. **28**: 209–235. 31 D 1930.

Valleau, W. D., & Johnson, E. M. The relation of some tobacco viruses to potato degeneration. Kentucky Agr. Exp. Sta. Bull. 309: 475–507. *pl. 1–5*. Jl 1930.

Verrall, A. F. Die-back of elm in Minnesota. Phytopathology **20**: 1004–1005. D 1930.

Vickery, H. B. Some aspects of the chemistry of green leaf cells. Sci. Monthly **31**: 408–421. N 1930.

Victorin, Marie- (Frère). Les variation laurentiennes du *Populus tremuloides* et du *P. grandidentata*. Contr. Bot. Univ. Montreal 16: 1–16. *f. 1–4*. 1930.

Walker, M. N. Cotton diseases in Florida. Florida Agr. Exp. Sta. Bull. 214: 1–32. *f. 1–15*. My 1930.

Wardlaw, C. W. The biology of banana wilt (Panama disease) II. Preliminary observations on sucker infection. Ann. Bot. **44**: 917–936. *f. 1–74*. O 1930.

Waterman, W. G. Plant communities. 1–140. Ann Arbor, Mich. 1924.

Mimeograph copy.

Watson, J. B., & Tilden, J. E. The algal genus *Schizomeris* and the occurence of *Schizomeris Leibleinii* Kützing in Minnesota. Trans. Am. Micros. Soc. **49**: 160–167. *pl. 18.* Ap 1930.

Weatherwax, P. The ontogeny of the maize plant. Bull. Torrey Club **57**: 211–219. "Ap 1930" 15 Ja 1931.

Weber, G. F. & West, E. Diseases of sweet potatoes in Florida. Florida Agr. Exp. Sta. Bull. 212: 1–40. *f. 1–24.* Mr 1930.

Wentz, J. B. The inheritance of germless seeds in maize. Iowa Agr. Exp. Sta. Res. Bull. 121: 347–378. *f.* 1. F 1930.

Werdermann, E. *Mamillaria microhelia* Werd. n. sp. Monats. Deutsch. Kakteen-Gesell. **2**: 236–238. *illust.* N 1930.

A Mexican plant.

Werdermann, E. *Mamillaria* (*Cochemiea*) *Poselgeri* Hildmann. Blüh. Sukk. **1**: *pl. 3.* O 1930.

Werdermann, E. *Mamillaria Gülzowiana* Werdermann. Blüh. Sukk. **1**: *pl. 1.* 1 O 1930.

Werdermann, E. *Mamillaria Hahniana* Werdermann. Blüh. Sukk. **1**: *pl.* 2. 1 O 1930.

Werdermann, E. *Mamillaria hidalgensis* I. A. Purpus. Blüh. Sukk. **1**: *pl. 4.* 1 O 1930.

West, J. *Pleiospilos Bolusii.* Jour. Cactus & Succ. Soc. Am. **2**: 363–366. *illust.* D 1930.

Whitaker, T. W. Chromosome numbers in cultivated cucurbits. Am. Jour. Bot. **17**: 1033–1040. *pl. 63.* "D 1930" 8 Ja 1931.

White, C. T. Note on *Darlingia spectatissima* F. V. Muell., with description of a new variety. Jour. Arnold Arbor. **11**: 231. O 1930.

Williams, R. S. Pleistocene mosses from Minneapolis, Minnesota. Bryologist **33**: 33–36. *pl. 5.* "My 1930." 7 Ja 1931.

Includes descriptions of *Neocalliergon integrifolium*, gen. & sp. nov., and *Drepanocladus minnesotensis* sp. nov.

Williams, R. S. Some deep-water mosses. Bryologist **33**: 32. "My 1930" 7 Ja 1931.

Wolfe, J. J. Diatoms of Beaufort. Jour. Elisha Mitchell Sci. Soc. **46**: 89–94. N 1930.

Edited by Bert Cunningham, after the death of Dr. Wolfe.

Magnesium injury of wheat

Sam F. Trelease and Helen M. Trelease

(with two text figures and plates 5–8)

A pronounced pathological modification of leaves of young wheat plants growing in culture solutions was described by Tottingham (1914) and termed by him magnesium injury. The most characteristic form of this leaf injury is represented by a rolling and coiling of the young leaf during emergence from the sheath. The symptoms of magnesium injury of wheat are so conspicuous and distinctive that this disease furnishes a remarkable example of growth derangement resulting from disturbed salt nutrition. This injury was described by Tottingham (1914), Shive (1915), and Trelease (1920) as characteristic of cultures whose solutions had high ratios of magnesium sulphate to calcium nitrate. The occurrence and severity of magnesium injury appear to be definitely related to the ionic ratio of magnesium to calcium in the culture solution. The production of this injury is one of the most striking cases in which a clear relation has been demonstrated between an ionic ratio and the development of the plant.

The experiments reported in the present paper were undertaken with the aim of obtaining further information concerning the nature and symptoms of magnesium injury of wheat and the conditions determining its appearance in plants grown in solution cultures. In particular, this study was planned to include tests that would indicate more clearly than previous work whether the characteristic symptoms are to be ascribed to magnesium toxicity or to calcium deficiency.

GENERAL METHODS

The culture methods employed in this study were essentially the same as those described in previous papers (Trelease and Livingston, 1924; Trelease and Trelease, 1924, 1928). Marquis spring wheat (supplied by the University of Saskatchewan) was soaked for three hours in distilled water and then germinated on wet filter paper in glass culture dishes (24 cm. in diameter). When the primary root of each seedling was about 6 mm. long, selected seedlings were placed upon paraffined bobbinet stretched over enamelled iron pans (25 cm. in diameter and 8 cm. deep) filled with distilled water. Each of the pans was placed in a similar, but slightly larger pan, and distilled water was poured into the space between the two

[The Bulletin For February (58: 67–126) was issued 1 October 1931.]

TABLE 1

Magnesium injury and mean dry weights of tops of wheat plants of series 1, grown for 49 days, from March 22 to May 10, 1929, in culture solutions varying in ratio of magnesium chloride to calcium chloride. Actual concentrations of magnesium chloride and calcium chloride in these solutions are four times as great as those for series 2.[a]

Solution number	Mg/Ca ratio	Concentration of $MgCl_2$	Concentration of $CaCl_2$	Magnesium injury of third leaf		Mean dry weights	
				Number	Percentage	Actual	Relative
		M	*M*			*Milligrams*	
1	1.00	0.01	0.01000	0	0	125.0±1.9	100
2	1.75	0.01	0.00572	0	0	120.4±2.6	96
3	3.06	0.01	0.00327	0	0	116.5±1.9	93
4	5.35	0.01	0.00187	0	0	104.1±1.5	83
5	9.35	0.01	0.00107	12	30	89.3±1.6	71
6	16.39	0.01	0.00061	32	80	76.3±1.2	61
7	28.57	0.01	0.00035	37	93	62.3±1.4	50
8	50.00	0.01	0.00020	40	100	48.4±1.0	39

[a] Each solution also contained 0.002 M KH_2PO_4, 0.002 M K_2SO_4, 0.002 M NH_4NO_3, and 0.00001 M $FeSO_4$.

pans until the level of the water was even with the top of the smaller pan. During the first two days a moist chamber was provided for the seedlings by placing the cover of a glass culture dish on each netting. On the next day selected seedlings about 4 cm. high were transferred to the culture solutions.

The culture vessels were cylindrical, glazed earthenware jars (so-called chemical stoneware) obtained from the General Ceramics Company. Each jar had a capacity of about 7000 cc. For use as a culture vessel, the jar was nearly filled with solution and covered with a paraffined Portland cement disk having five circular openings, in which were set the cork stoppers supporting the plants (pl. 8). Each stopper bore eight seedlings, thus making forty seedlings in a culture. The cultures were placed on rotating tables in the greenhouse where all of the plants were exposed to approximately the same fluctuations in environmental conditions throughout the period of the experiment.

The solutions were renewed frequently enough for each plant to be supplied with an amount of solution corresponding to about 56 cc. per day. The seedlings were grown in the culture solutions for 40 or 49 days. Notes were made of the appearance of the tops and roots, special attention being given to symptoms of magnesium injury. At the conclusion of the culture period the tops of the individual plants of each culture were harvested separately and dried for 20 hours, to an approximately constant weight, at 101° C. The top dry weight of each plant was then determined.

Four series of cultures are described in the present paper. Data for these are shown in tables 1–4, respectively. Each table gives the period of the experiment and the culture solutions employed. It also shows the data that were obtained for magnesium injury and dry weights of tops. The first series was carried on in one of the old greenhouses of Columbia University; the last three series were conducted simultaneously in the new roof greenhouse, which forms the twelfth story of Schermerhorn Extension.

SYMPTOMS OF MAGNESIUM INJURY

Injury of the third leaf

Emergence of tightly rolled leaf apex. Magnesium injury becomes visible after young wheat plants have grown in the culture solutions for from nine to twelve days, when the young, third leaf is just emerging from the sheath. The coleoptile and the first and second green leaves develop normally. But the third leaf of some cultures shows characteristic symptoms of injury. As it emerges from the sheath, the injured leaf is much more tightly rolled than a normal leaf. The rolling of the leaves is in the same

TABLE 2

Magnesium injury and mean dry weights of tops of wheat plants of series 2, grown for 40 days, from October 31 to December 10, 1930, in culture solutions varying in the ratio of magnesium chloride to calcium chloride. Actual concentrations of magnesium chloride and calcium chloride in these solutions are one-fourth as great as those for series 1.[a]

SOLUTION NUMBER	Mg/Ca RATIO	CONCENTRATION OF $MgCl_2$	CONCENTRATION OF $CaCl_2$	MAGNESIUM INJURY				MEAN DRY WEIGHTS	
				Third leaf		Fourth leaf			
				Number	Percentage	Number	Percentage	Actual	Relative
		M	*M*					*Milligrams*	
1	1.00	0.0025	0.002500	0	0	1	3	115.1±2.1	100
2	1.75	0.0025	0.001429	0	0	7	18	108.2±2.2	94
3	3.06	0.0025	0.000817	1	3	31	78	101.3±2.2	88
4	5.35	0.0025	0.000467	2	5	39	98	94.6±1.9	82
5	9.35	0.0025	0.000267	13	33	40	100	82.3±1.4	72
6	16.39	0.0025	0.000153	37	93	40[b]	100	70.1±1.0	61
7	28.57	0.0025	0.000088	40	100	40[c]	100	67.3±0.7	58
8	50.00	0.0025	0.000050	40	100	40[d]	100	62.0±0.7	54

[a] Each solution also contained 0.002 M KH_2PO_4, 0.002 M K_2SO_4, 0.002 M NH_4NO_3, and 0.00001 M $FeSO_4$.
[b] Only 29 fourth leaves had emerged from sheath.
[c] Only 9 fourth leaves had emerged from sheath.
[d] No fourth leaves had emerged from sheath.

direction as that of the normal young leaf—that is, the upper surface of the blade remains inside (fig. 4, pl. 6; fig. 9, 10, 11, pl. 7). The injured leaf is darker green in color than a healthy leaf, and it grows out of the sheath at a slower rate (fig. 2, pl. 5). The apical portion that has emerged does not unroll subsequently; it dries and remains as a stiff, wire-like structure, that may be erect or sinuous.

Spiral deformation within sheath. The most striking and characteristic abnormality of a leaf affected with magnesium injury is a spiral deformation that develops below the tightly rolled apical portion (fig. 3, pl. 5; fig. 4, 5, 6, pl. 6; fig. 8, pl. 7). The spiral forms within the sheath while the needle-like apical portion of the leaf is emerging. The spiral develops as a result of the failure of the apical part to move upward through the sheath as rapidly as elongation occurs at the base of the leaf. A wilting or withering of the leaf tissues appears to occur in the region of the spiral, and continued growth pressure from below crushes a considerable length of the enclosed leaf into a close spiral, which may vary in length from a few millimeters to a centimeter or more. The upper part of the surrounding sheath seems to be rolled so tightly that it obstructs the upward movement of the distal portion of the leaf. The spiral that is produced does not wind continuously in one direction; the direction usually is reversed several times, with compact, irregular loops separating the more perfectly formed spiral regions.

The mechanical process by which the spiral is formed may be simulated by forcing a considerable length of wire into a glass tube, closed at the far end and having a bore several times the diameter of the wire. The resulting distortion of the wire, into a close spiral with several reversals of direction, appears to be essentially the same as that of the leaf. Pressure from below, rather than a contraction within the region of the spiral, results in the coiling. Yet a spiral that has been lengthened by application of tension contracts partially when the tension is released.

Severely injured portions of the leaf exhibit a dark-green color that suggests an infiltration of intercellular spaces with liquid. The compressed, dark-green spiral may be seen as a silhouette within the translucent sheath if the plant is viewed by transmitted sunlight. This may be seen with special clearness when an injured fourth leaf is contained within the sheath of a normally developed third leaf.

Emergence of spiral from sheath. In cases of very severe injury, growth of the injured leaf soon ceases, so that only the very tightly rolled, dark-green apex of the leaf emerges from the sheath (fig. 2, pl. 5). But if injury is less severe, basal growth of the leaf continues for some time and the coiled part of the leaf emerges from the sheath (fig. 3, pl. 5), followed by a rolled portion below the spiral. The spiral generally assumes a horizontal

TABLE 3

Magnesium injury and mean dry weights of tops of wheat plants of series 3, grown for 40 days, from October 31 to December 10, 1930, in culture solutions varying in the ratio of magnesium chloride to calcium chloride. Solution 1 of this series is the same as solution 3 of series 1.[a]

SOLUTION NUMBER	Mg/Ca RATIO	CONCENTRATION OF $MgCl_2$	CONCENTRATION OF $CaCl_2$	MAGNESIUM INJURY				MEAN DRY WEIGHTS	
				Third leaf		Fourth leaf			
				Number	Percentage	Number	Percentage	Actual	Relative
		M	*M*					*Milligrams*	
1	3.06	0.0100	0.00327	1	3	25	63	120.4±2.5	100
2	5.35	0.0175	0.00327	2	5	32	80	105.5±2.2	88
3	9.35	0.0306	0.00327	4	10	34	85	104.5±2.0	87
4	16.39	0.0536	0.00327	10	25	33	83	86.5±1.4	72

[a] Each solution also contained 0.002 M KH_2PO_4, 0.002 M K_2SO_4, 0.002 M NH_4NO_3, and 0.00001 M $FeSO_4$.

TABLE 4

Magnesium injury and mean dry weights of tops of wheat plants of series 4, grown for 40 days, from October 31 to December 10, 1930, in culture solutions varying in the concentration of strontium chloride. Solution 1 of this series is the same as solution 6 of series 1.[a]

SOLUTION NUMBER	CONCENTRATION OF $SrCl_2$	Mg/(Ca+Sr) RATIO	MAGNESIUM INJURY				MEAN DRY WEIGHTS	
			Third leaf		Fourth leaf			
			Number	Percentage	Number	Percentage	Actual	Relative
	M						*Milligrams*	
1	0.00000	16.39	34	85	40	100	76.1±1.2	100
2	0.00001	16.13	33	83	37	93	84.3±1.4	111
3	0.00003	15.63	32	80	33	83	86.3±1.6	113
4	0.00010	14.08	26	65	35	88	87.6±1.3	115
5	0.00032	10.75	20	50	32	80	89.2±1.5	117
6	0.00100	6.21	21	53	33	83	95.2±1.6	125
7	0.00316	2.65	13	33	—[b]	—	75.6±1.5	99
8	0.01000	0.94	1	3	—[c]	—	40.7±0.4	53

[a] Each solution also contained 0.002 M KH_2PO_4, 0.002 M K_2SO_4, 0.002 M NH_4NO_3, 0.00001 M $FeSO_4$, 0.010 M $MgCl_2$, and 0.00061 M $CaCl_2$. Ratio of $MgCl_2$ to $CaCl_2$, 16.39.

[b] Only 7 fourth leaves had emerged from sheath.

[c] Only 4 fourth leaves had emerged from sheath.

or drooping position after emergence (fig. 4, 5, pl. 6; fig. 8, pl. 7). Rarely, a second spiral forms within the sheath and later emerges (fig. 6, pl. 6).

Emergence of lower portion of leaf. As just mentioned, if the injury is very severe, only the needle-like apical portion, from one to five centimeters in length, emerges from the sheath. In rare cases emergence of the lower part of the leaf occurs through the side of the enveloping sheath rather than at the top (fig. 7, pl. 6). The apex of the leaf may first emerge for a short distance out of the opening at the top of the sheath. Then a part of the leaf several centimeters long wilts, becomes very thin and thread-like, and remains irregularly coiled and looped within the sheath. Finally a region below this remains turgid and, though greatly distorted, is forced out through the side of the sheath, unrolling the latter sufficiently to permit a considerable portion of the leaf to emerge.

If the injury is somewhat less severe, the spiral issues at the top of the sheath, followed by a tightly rolled portion that does not expand after emergence. When the injury is milder, the part of the leaf below the spiral emerges rapidly and expands normally; at maturity the leaf attains the same length as that of an uninjured leaf, twenty to twenty-five centimeters (fig. 9, pl. 7). A still lower degree of injury is characterized by the formation of a long, loose spiral, several centimeters in length, followed by a normally expanded blade (fig. 10, pl. 7).

In other cases no spiral is formed. Below the tightly rolled apex emergence is rapid, and the only sign of injury in the lower portion is the presence in the expanded leaf of one or more marginal lacerations, sometimes extending to the midrib (note laceration in fig. 10, pl. 7). Very slight injury of many leaves is indicated by a tightly rolled apical portion, often from one to three centimeters in length (fig. 11, pl. 7). The tip of the leaf is closely rolled as it emerges from the sheath and it fails to expand later. But the rest of the leaf emerges and unrolls normally and reaches the usual size of healthy leaves. This type of slight injury is frequently observed in rapidly growing plants, and it has only slight influence on final dry yields. Leaf injury apparently never occurs in leaves that have emerged normally and have developed to the usual size. Old leaves frequently exhibit rolled apices, which remain green for some time and finally die and become yellow. But apical injury of these leaves appears always to have occurred while the leaf was in an early stage of its development and emerging from the sheath.

Leaf-tip abscission. Abscission of the tightly rolled, needle-like tips of injured leaves frequently occurs. In the most severely injured plants leaf-tip abscission may take place after the seedlings have been in the culture solutions for only ten days. The tip, two or three centimeters long, then

breaks from the plant at the sheath opening (position clearly shown in fig. 2, pl. 5); subsequent examination of the plant may reveal no external sign of the injured leaf. Most of the leaf tip is dark-green in color when it becomes separated from the plant; a yellow discoloration usually extends only a very short distance above the point of abscission. When the injury is less severe, abscission may occur later, at the base of the spiral after that has emerged. In cases of very slight injury the rolled apex frequently becomes yellow and dry, but it usually remains attached to the rest of the leaf (fig. 11, pl. 7).

Injury of the fourth leaf

The symptoms of magnesium injury of the fourth leaf are similar to those just described for the third leaf. Injury of the fourth leaf tends to be of more general occurrence, however. In many cases the fourth leaf is affected even though the third leaf has escaped injury. Thus, eighty per cent of the fourth leaves of a culture may be affected after all but two per cent of the third leaves have escaped injury. If the third leaf has been very severely injured, the fourth leaf usually fails entirely to emerge from the sheath, though in rare cases emergence may occur at a lower point than normal, through the side of the sheath. The fifth leaf may exhibit the typical symptoms of magnesium injury even though earlier leaves have developed normally.

Other derangements accompanying magnesium injury of leaves

Dark-green color of leaves of injured plants. Leaves of plants suffering from magnesium injury are greener in color than those of normal plants. This suggests a direct relation between the color and the amount of magnesium present in the cells. The greenness of the foliage is roughly proportional to the severity of the magnesium injury; the color of the foliage is darkest in the most severely injured plants, and the depth of green decreases in passing from severely to slightly injured plants. The apical parts of the severely injured leaves generally die and then become yellow or brown, but the living parts remain dark green in color.

Premature tillering associated with leaf injury. A number of tillers develop prematurely on plants exhibiting the most pronounced abnormalities of leaf development, and the tillers themselves show characteristic symptoms of magnesium injury. These tillers usually arise at the time when the third or fourth leaf is appearing on normal plants, and they develop in greatest numbers on plants which are so severely injured that the third or fourth leaf fails to emerge fully from the sheath. This suggests that such premature branching from the base of the stem is a response to severe injury of the stem apex, resulting in loss of apical dominance.

Anatomical and histological studies would be of great interest in this connection. Premature tillering of course is not a specific symptom of magnesium injury. It is very conspicuous, for example, in plants suffering from strontium poisoning. The tillers that develop as a result of magnesium toxicity generally exhibit the characteristic symptoms of magnesium injury (fig. 1, pl. 5).

Inhibition of root development. Root development may be markedly retarded in plants exhibiting symptoms of the most pronounced leaf injury. Growth in length, both of the main roots and of their lateral branches, proceeds less rapidly and ceases earlier than in the less severely injured plants. Thus, a stunted root system is associated with severe magnesium injury of the foliage. Root development is apparently normal, however, if injury to the tops is slight.

Production of adventitious roots. Extremely severe magnesium injury of the primary root of a wheat seedling often results in the early development of several adventitious roots. Six roots, instead of the usual two or four, frequently push out from the young seedling at about the same level as the central primary root, and then still another adventitious root may emerge very early from the stem, just above the primary root. These adventitious roots seem to develop prematurely as a response to severe injury of the primary root. They appear to be less sensitive to the toxic medium than the primary root and the first lateral pair of seminal roots, since they frequently grow to a much greater length in the solution. This suggests the possibility that these roots are less permeable to the toxic substance. The development of several adventitious roots of this kind, however, is not a specific symptom of magnesium injury; it may result also when other poisons—copper salts, for example—are supplied in highly toxic concentrations.

CONDITIONS INFLUENCING MAGNESIUM INJURY

Magnesium injury in relation to the ratio of magnesium to calcium in the culture solution

The occurrence of the characteristic form of leaf injury described in the preceding section of this paper has been shown to depend upon the ionic ratio of magnesium to calcium in the culture solution (Tottingham, 1914; Shive, 1915; Trelease, 1920). This is one of the few cases thus far reported in which a clear relation has been demonstrated between the value of an ionic ratio and the development of the plant.

Tottingham (1914) employed eighty-four solutions containing KNO_3, KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ in each of three series of wheat cultures. All possible proportions of the four salts were used that could be produced

by varying each salt by one-tenth of the total osmotic concentration of all salts. The three series had concentrations corresponding to 0.05, 2.50, and 8.15 atmospheres, respectively. No leaf injury was observed in the cultures of the first series. But the characteristic rolling and coiling of the young leaves, termed magnesium injury by Tottingham, was conspicuous in the second and third series, having the higher concentrations. Magnesium injury was clearly related in these series to the ratio of magnesium to calcium in the solutions. The cultures characterized by the highest values of this ratio were all severely injured, those with the lowest values were free from injury, and those with intermediate values showed some injury. No

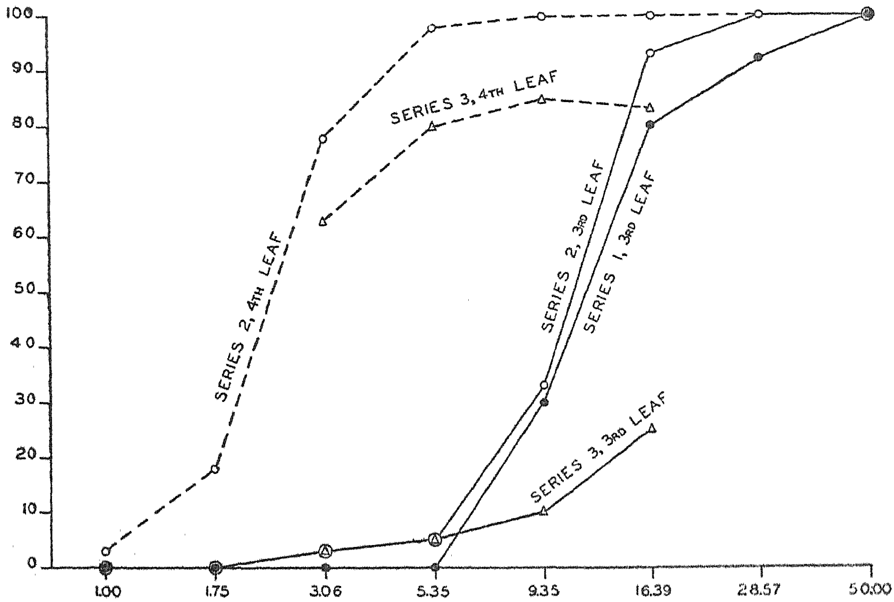


Fig. 1. Magnesium injury of wheat plants as related to the magnesium-calcium ratios of the culture solutions. Abscissas represent magnesium-calcium ratio values plotted on a logarithmic scale. Ordinates represent percentages of leaves exhibiting magnesium injury.

Graphs for series 1–3 are plotted from the data of tables 1–3.

injury occurred with ratio values below 0.40, when the osmotic value was 2.50 atmospheres, and none appeared below 0.28, when the osmotic value was 8.15 atmospheres.

Shive (1915) found that when his three-salt solutions, containing KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$, had an osmotic value of 1.75 atmospheres and magnesium-calcium ratios of less than 1.5, the plants were free from magnesium injury, and that when the solutions had an osmotic value of

4.00 atmospheres this limit occurred with the ratio value 2.2. Shive demonstrated clearly that the occurrence of injury was set by the magnitude of the ratio of magnesium to calcium. It was not determined by the actual concentration of any one salt or ion, nor did it bear any definite relation to either of the ratios Mg/K or Ca/K.

Trelease (1920) used eighty-four solutions like those of one of Tottingham's series but with KNO_3 replaced by KCl. With these solutions having an osmotic value of 1.60 atmospheres, severe magnesium injury was clearly confined to ratio values that lay between 1.65 and 13.43 (the highest tested); slight injury occurred when the magnesium-calcium ratios lay between the limits 0.81 and 3.64; and entire freedom from this form of injury was shown in the cultures which had ratio values below 0.81.

Severity of injury as related to the magnesium-calcium ratio. Series 1–3 of the present study bring out a very clear relation between the severity of magnesium injury and the ratio of magnesium to calcium in the culture solution. The results are presented in tables 1–3 and they are plotted in figure 1, in which the abscissas represent the ratios of magnesium to calcium (plotted on a logarithmic scale) and the ordinates represent the percentages of leaves exhibiting magnesium injury.

The graphs of figure 1 show that a marked rise in the percentage of injured leaves accompanied an increase in the value of the ratio of magnesium to calcium. They also show that injury to fourth leaves was much more general than to third leaves. It is interesting to note that series 1 and 2 gave essentially the same results, although the actual concentrations of magnesium and calcium were four times as great in the first series as in the second. This supports the conclusion that the ratio value of magnesium to calcium, rather than the actual concentration of either, mainly determines the extent of the leaf injury.

The results here noted were secured by means of variations in the ratio of $MgCl_2$ to $CaCl_2$. Since a common anion was employed, the effects may be attributed to the cation ratio of magnesium to calcium. Tottingham, Shive, and Trelease varied the proportions of $Ca(NO_3)_2$ and $MgSO_4$, and so the effects they recorded might have been due to the nitrate-sulphate ratio.

The more general occurrence of injury to the fourth leaf than to the third is strikingly brought out by the graphs for series 2 and 3. Injury was never observed in the coleoptile, nor in the first and second green leaves. The fourth leaf often was affected even though the third escaped. In some cases the fifth or the sixth exhibited injury after all of the others had been free from it. When the plants had grown for a sufficiently long period to allow the development of seven leaves, the number of leaves affected on

each plant was greatest in the cultures supplied with solutions of moderate toxicity. The fourth, fifth, sixth, and seventh leaves of such cultures often showed slight injury, whereas the corresponding leaves did not emerge at all in the cultures that had the most toxic solutions.

The curves of figure 1 show that equivalent magnesium-calcium ratios produced considerably less injury in series 3 than in series 1 and 2. This observation supports the indications recorded in the papers of Tottingham and Shive that the simple ratio of magnesium to calcium does not completely determine the quantitative expression of magnesium injury. The solutions of series 3 have much higher absolute concentrations of calcium and magnesium than those of the other two series. Thus in the solution of series 3 for which the magnesium-calcium ratio is 16.39, the actual concentration of calcium is 5.36 times the corresponding concentration in series 1 and it is 21.44 times that in series 2; the concentration of magnesium in the solution of series 3 is, of course, correspondingly high. With equivalent ratio values, magnesium injury was less pronounced in these cases when the actual contents of calcium and magnesium were very high than when they were relatively low. It is to be noted that the severity of magnesium injury was essentially the same in series 1 and series 2, although the actual concentrations of calcium and magnesium were four times as high in the former series as in the latter. But with the still higher calcium and magnesium contents of series 3, the injury was less severe. These cases suggest that when the actual concentration of magnesium was greatly increased, magnesium toxicity could be checked without increasing the calcium in the same proportion.

Antagonistic salt action illustrated by magnesium injury. The direct relation between the severity of magnesium injury and the value of the ratio of magnesium to calcium in the culture solution appears to afford a clear case of antagonistic salt action. The effect of calcium in diminishing the magnesium injury of wheat seems to be similar to many cases of salt antagonism reported in the literature (Loew, 1892, 1903; Loew and May, 1901; Loeb, 1906; Osterhout, 1922; McCool, 1913; Hansteen, 1910; Trelease and Trelease, 1925, 1926; Eisenmenger, 1928; Barton and Trelease, 1927). Leaf development may thus be used as a criterion of toxicity and antagonism in the same way that growth rate, duration of life, electrical conductivity of tissues, and rate of absorption or excretion of electrolytes have been employed in many studies.

Magnesium injury of the foliage does not occur when the concentrations of magnesium and calcium are properly balanced in the culture solution. The absorption of magnesium is probably retarded when a sufficient proportion of calcium is present in the solution. And we may suppose that

the magnesium which is absorbed from the balanced solution produces no harmful effects, because it is accompanied by a suitable quantity of calcium.

Apparent specificity of magnesium injury. The characteristic deformation of the foliage which has been described as magnesium injury appears to be a specific effect of magnesium toxicity, associated with culture solutions having high magnesium-calcium ratio values. No other solution condition capable of producing identical symptoms was discovered in the extensive studies of Tottingham and Shive, and none seems to have been reported by other investigators. It is true that symptoms similar in some respects to those of magnesium injury have been described by Gericke (1922) as occurring in wheat plants supplied with a simple solution of potassium sulphate, potassium nitrate, or potassium dihydrogen phosphate. The relation of these symptoms to those of magnesium injury is not entirely clear, however. A repetition of Gericke's tests confirmed his observation that the young third leaf emerged from the sheath in an abnormally tightly rolled condition and that abscission of the leaves often occurred. Thus the initial symptoms were undoubtedly similar to those of magnesium injury. But the plants in simple solutions of the potassium salts died after from two to three weeks, and none of them developed the spiral deformity that is the most characteristic sign of magnesium injury.

A striking resemblance to magnesium injury of wheat has been shown by the inflorescences of wheat and rye attacked by the fungus *Dilophospora alopecuri* (Schaffnit and Wieben, 1928). The most pronounced deformities of spikes, leaves, and leaf sheaths of wheat occurred when the plants were attacked simultaneously by *Dilophospora alopecuri* and *Tylenchus tritici*. The spikes were prevented from emerging properly from the leaf sheaths, and the continued growth of the culm produced spiral malformations resembling those of magnesium injury. But the spiral deformation took place only in the inflorescences—not in the young leaves of the seedling plant.

Although symptoms of young seedlings identical with those of magnesium injury have not been described thus far as resulting from toxic agents other than magnesium, we should expect that other chemical elements or compounds would be capable of producing similar abnormalities in the growth of wheat seedlings. The response seems to involve a rather simple type of obstruction to growth, and there is little reason to suppose that magnesium is the only agent that can induce it.

Variations in symptoms correlated with differences in the magnesium-calcium ratio. In the present work no attempt was made to keep quantitative records of the different types of leaf injury that occurred in the various

cultures. Tottingham (1914) classified the injured leaves into those exhibiting slight and those exhibiting severe injury. Shive (1915) also divided the injured leaves into two groups—those which were injured throughout their entire length, and those which were normal except for an injured apical region. A similar classification was adopted by Trelease (1920) in recording the injury: when a spiral was formed or when the whole leaf was affected, the injury was considered severe; when no spiral was formed and the whole leaf was not affected, the injury was considered slight. Considerable difficulty is encountered, however, in the use of two classes of this sort. For example, at a certain time the whole leaf may appear to be affected; but subsequent examination may show that the leaf has grown out of the sheath, so that all but the apical portion has developed normally. In the present study, therefore, exact records were kept only of the number of injured leaves in each culture.

Some observations that were made with regard to the distribution of the different types of injury are interesting, however. It was observed that the most conspicuously developed long spirals occurred in the moderately, rather than in the most severely injured cultures. They were common, for example, among the third and fourth leaves of culture 5 (magnesium-calcium ratio, 9.35) of series 1 and 2. On the other hand, very few cases of long spirals were found in the most severely injured plants (e.g., those of culture 8 with a magnesium-calcium ratio of 50.00); in these plants only a thin, tightly rolled, thread-like portion of the leaf emerged from the sheath. Furthermore, the well developed elongated spirals were of more frequent occurrence among fourth leaves than among third leaves. Slightly injured leaves, in which the apical portion remained rolled while the lower part emerged and developed normally, were of course produced in the greatest numbers in the less toxic solutions, with relatively low magnesium-calcium ratios.

Magnesium toxicity and calcium deficiency

The question may be raised as to whether the growth derangements that have been termed magnesium injury are to be attributed to magnesium toxicity or to calcium deficiency. Sufficient information, however, is hardly available as yet for a definite answer.

It has been clearly shown that injury to the foliage does not occur when the concentration of magnesium is sufficiently low in relation to that of calcium. As the magnesium-calcium ratio value is increased, the injury becomes more and more severe. This relationship in itself suggests magnesium toxicity as the controlling condition. It may be supposed that magnesium is absorbed rapidly enough to be injurious when supplied in solutions that

have a relatively low calcium content; or it may be considered that magnesium exerts its toxic effects when entering the plant unaccompanied by a sufficiently high proportion of calcium. Many studies have shown that simple solutions of magnesium salts are highly toxic to roots, but that this toxicity disappears if a sufficient proportion of calcium is added to the culture solution (see, for example, Trelease and Trelease, 1926). On the other hand, the effects of calcium starvation are relatively slow in making their appearance; the roots of young wheat seedlings make rapid and apparently normal growth for a number of days in distilled water, which of course is devoid of calcium. Sufficient calcium to supply the needs of the plant is probably furnished by the material stored in the seed. These facts seem to support the idea that the abnormality of leaf growth is dependent upon magnesium toxicity.

If the foliage symptoms are to be regarded as due to calcium starvation, we must suppose that sufficient calcium for normal leaf development cannot be absorbed when there is an excess of magnesium in the solution surrounding the roots, or that the calcium, even though absorbed, is unavailable for proper utilization by the plant when accompanied by an excess of magnesium.

The cultures of series 4 seem to throw some light on this question. They appear to furnish evidence that the injury is due to magnesium toxicity rather than to calcium starvation. It will be noted from table 4 that the first solution had a magnesium-calcium ratio of 16.39, and that this solution produced typical injury in 85 per cent of the third leaves. The other solutions contained strontium chloride in increasing concentrations. It is apparent from these data that the addition of strontium chloride had a definite inhibiting effect on the injury to the third leaf. When the fourth leaf is considered, however, no inhibition of magnesium injury is evident. Strontium exerted its own toxic effect. Concentrations of strontium high enough to check magnesium injury of the third leaf were so toxic to the plant that they prevented the fourth leaf from emerging from the sheath.

The observations on the third leaf, however, indicate that strontium was able to delay the appearance of the characteristic symptoms of magnesium injury. The partial inhibition of magnesium injury by strontium points to the conclusion that this injury really is due to magnesium toxicity rather than to calcium starvation.

Studies of the influence of variations in the total concentration of the culture solution afford additional evidence against the idea that calcium deficiency produces the growth derangements that have been termed magnesium injury. It has been found that reducing the calcium concentration

in the external solution by diluting the culture solution does not increase the severity of the injury. On the contrary, it appears to decrease it. Thus Shive and Tottingham reported that no coiling of the leaves occurred in their suboptimal solutions corresponding in osmotic value to 0.1 and 0.05 atmosphere.

Magnesium injury as influenced by substances other than magnesium and calcium in the culture solution

Although the magnesium-calcium ratio seems mainly to determine the occurrence and severity of magnesium injury, there is evidence that this injury may be influenced by other substances present in the solution. Thus Tottingham (1914) observed that serious leaf injury increased rapidly as the partial concentration of KH_2PO_4 increased in his solutions of high total concentration (8.15 atmospheres). He points out that this indicates an inter-relation of all solutes in determining the harmful effects of magnesium. It is suggested that the acidity of KH_2PO_4 may have been influential.

Shive's triangular diagrams representing the distribution of severe and slight leaf injury in his optimal (1.75 atmospheres) and supra-optimal (4.00 atmospheres) solutions also show that the severity of the injury produced by a given magnesium-calcium ratio increases with an increase in the partial concentration of KH_2PO_4. Similarly, in another study it was found that the injury extended to lower values of the magnesium-calcium ratio when KCl was present in the solution in high enough partial concentrations to constitute eight-tenths or nine-tenths of a total osmotic value of 1.60 atmospheres (Trelease, 1920).

The results of these studies indicate that the injurious effect of magnesium is controlled by the complex balance between magnesium and all of the other substances present in the culture solution. Magnesium toxicity may be thought of as mainly determined by the magnesium-calcium ratio, but as also influenced somewhat by the proportions and concentrations of other materials present in the solution.

Relation of magnesium injury to the total concentration of the culture solution

Characteristic magnesium injury, involving a spiral deformation of the foliage, has not been reported as occurring in very dilute solutions, even though these have high magnesium-calcium ratio values. Thus Tottingham (1914) found that only one young third leaf exhibited magnesium injury in his series of cultures with a total osmotic value of 0.05 atmosphere. Although this one case developed into a severe stage, no

further trace of injury became visible in this series of cultures; this single case of injury may have been due to a specific weakness or susceptibility of the particular leaf involved. Pronounced injury, however, appeared in the cultures of the series of higher osmotic value—2.50 and 8.15 atmospheres. Shive (1915) also noted marked injury in his cultures with osmotic values of 1.75 and 4.00 atmospheres, but none in the corresponding cultures supplied with solutions diluted to 0.1 atmosphere.

Severe magnesium injury, involving coiling of the leaves, occurred in all tested concentrations, from 7.0 atmospheres to 0.5 atmosphere, of a solution containing KCl, KH_2PO_4, $Ca(NO_3)_2$, and $MgSO_4$ and having a magnesium-calcium ratio value of 13.43 (Trelease, 1920). The severity of the injury as well as the number of leaves affected increased with an increase in the total concentration. Even the lowest concentration that was tested (0.5 atmosphere) was high enough to produce the typical magnesium injury.

Some incomplete series of cultures, grown during the spring of 1931, have shown that injury of the young third and fourth leaves occurred when the solution was diluted to 1/4, 1/16, and 1/64 of an atmosphere; but the most conspicuous and characteristic form of injury, marked by a coiling of the leaves, was not found in the most dilute solutions. In these, the young leaf emerged in a tightly rolled condition, but the development did not proceed to the stage in which a well developed spiral is formed. Cessation of growth before the fourth leaf had completely emerged made it very difficult to obtain an accurate record of magnesium injury. Further work will be necessary before a satisfactory report may be made concerning this phase of the problem.

Relation of magnesium injury to climatic conditions

Remarkably consistent results were obtained in series 1 and 2, although these series were conducted at different seasons of the year. The degree of injury to the third leaf in these tests was nearly the same under very different sets of climatic conditions. An earlier study, however, suggested that the occurrence of the injury might have been influenced by aerial conditions (Trelease, 1920). A solution with a magnesium-calcium ratio of 1.72 and a total concentration of 1.60 atmospheres produced slight magnesium injury when used from January 11 to February 4, of 1916, but produced no injury when used from January 23 to February 24 of the following year. The fact that the aerial conditions were different may possibly explain why the injury was not apparent in the second test. Gericke (1922) states that magnesium injury presents itself in much greater degree under conditions conducive to high transpiration of the plants than to low.

Magnesium injury in other plants

Oats, rye, and barley were found to exhibit symptoms of magnesium injury identical with those described for wheat. This observation was made on cultures of the other cereals grown with the wheat cultures of series 1 and supplied with solution 6. All of the characteristic symptoms of magnesium injury developed in plants of these cultures. A series of corn cultures (*Zea Mays*) conducted in the spring of 1931 showed that this plant also develops signs of injury that resemble those of the small grains. Pro-

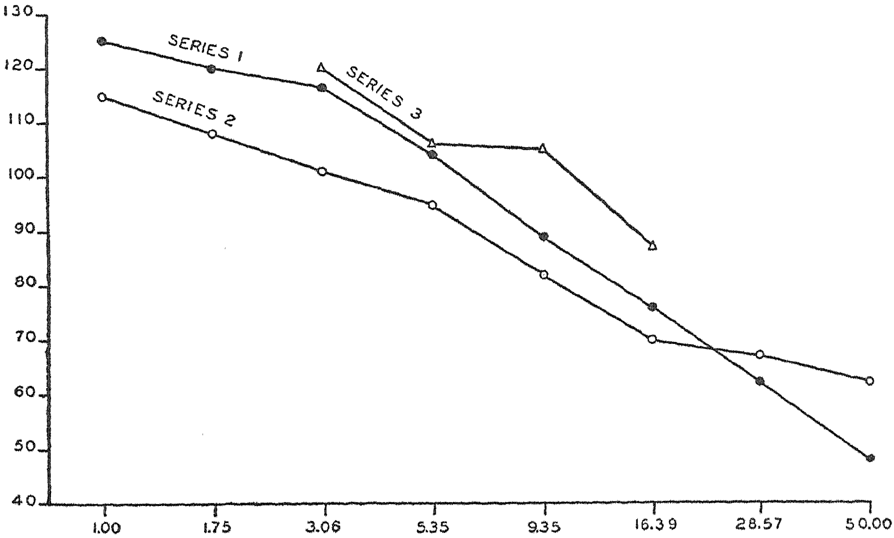


Fig. 2. Dry weights of tops of wheat plants as related to the magnesium-calcium ratios of the culture solutions. Abscissas represent magnesium-calcium ratio values plotted on a logarithmic scale. Ordinates represent dry weights in milligrams.
Graphs for series 1–3 are plotted from the data of tables 1–3.

nounced leaf distortion occurred in solutions of high magnesium-calcium ratios. Spiral deformation was less common, however, in corn.

Tobacco also develops symptoms that resemble in some respects those of the grasses (Garner, McMurtrey, Bowling, and Moss, 1930). Tobacco plants that were grown in soil cultures with a very low supply of calcium in relation to that of magnesium exhibited striking pathological modifications of the upper leaves; the aborted leaves had large indentations in their margins and their tips were lacking. The growing points were affected to such an extent that in most cases the plants were unable to flower.

DRY WEIGHTS OF TOPS IN RELATION TO THE MAGNESIUM-CALCIUM RATIO

The dry weights of tops for series 1–3 are plotted as graphs in figure 2, in which ordinates represent mean weights in milligrams and abscissas

represent magnesium-calcium ratios plotted on a logarithmic scale. The most striking feature of these graphs is the nearly linear decrease in dry weight with an increase in the logarithm of the magnesium-calcium ratio. Thus dry yields of tops are inversely proportional to the logarithm of the magnesium-calcium ratio (between the ratio limits 1.00 and 50.00). In considering the somewhat higher yields for series 1 than for series 2, it should be remembered that these cultures were conducted at different seasons of the year; the higher values of the first series are not necessarily correlated with the fact that actual concentrations of magnesium and calcium were four times as great in this series as in the second. The graph for series 3, while exhibiting some irregularity, lies definitely above those for the other two series. The solutions of this series had much higher actual concentrations of magnesium and calcium than those of either of the other series. It is clear from this comparison that the actual dry weights that may be secured depend not only upon the magnesium-calcium ratio but also upon other characteristics of the solution.

No information regarding optimal magnesium-calcium ratios for growth is available from this study. The optimal ratio would have been 1.00 or lower, for these experimental conditions. Since the aim of the present work was to study magnesium injury, solutions of low magnesium-calcium ratio values were omitted. Other studies (Tottingham, 1914; Shive, 1915; Trelease, 1920) have shown that the dry yield is markedly reduced when solutions of very low magnesium-calcium ratio values are employed. Pathological symptoms of wheat which are quite different from those of magnesium injury may occur under these conditions; the symptoms that have been noted include bleaching of the tissues between the main veins and a general chlorosis of this foliage. The green color of the leaves becomes less intense with decrease in the magnesium-calcium ratio. The largest tops are intermediate in color. Garner, McMurtrey, Bacon, and Moss (1923) have shown that pronounced chlorosis of tobacco, known as sand-drown, is associated with magnesium deficiency. But how closely it is correlated with the magnesium-calcium ratio has not as yet been thoroughly investigated.

An antagonistic effect of strontium toward magnesium seems to be brought out clearly by the dry weights shown in table 4. The addition of successively higher concentrations of strontium is accompanied by a progressive increase in dry yield, until a maximum yield is reached when the solution contains 0.001 M $SrCl_2$. A further increase in the concentration of strontium results in a reduction of yield, due no doubt to the toxicity of the strontium.

SUMMARY

Magnesium injury of wheat becomes visible when the young third leaf is emerging from the sheath. The apical portion of this leaf remains tightly rolled. The most characteristic abnormality is a spiral deformation that is produced in the lower part of the young leaf, enclosed within the sheath. Emergence of the leaf is checked, and continued growth pressure from below crushes a considerable length of the leaf into a close spiral. Later the spirally distorted region may emerge from the sheath, followed by a rolled portion. Abscission of the tightly rolled, needle-like tips of injured leaves frequently occurs. The characteristic leaf deformation, marked by a spiral distortion of the young leaves, appears to be a specific symptom of magnesium toxicity.

Injury was not observed in the coleoptile, nor in the first and second green leaves. It was much more general in the fourth leaf than in the third. In some cases the fifth or the sixth leaf exhibited injury after all of the others had been free from it.

Other derangements accompany the deformation of the foliage. The leaves are darker green than those of normal plants, numerous tillers develop prematurely, growth of the seminal roots is inhibited, and a number of adventitious roots are produced.

The occurrence and severity of magnesium injury are mainly determined by the ratio of magnesium to calcium in the culture solution. This was shown by an increased percentage of injured leaves as the magnesium-calcium ratio increased from 1.00 to 50.00. Magnesium injury thus appears to afford a clear case of antagonistic salt action.

The leaf injury seems to be due to magnesium toxicity, rather than to calcium deficiency. This conclusion is supported by the observation that strontium was able to delay and partially inhibit the characteristic symptoms of magnesium injury.

Magnesium injury, while mainly controlled by the magnesium-calcium ratio, appears to be influenced by the proportions and concentrations of other materials present in the culture solution, as well as by the total concentration of the solution and possibly also by climatic conditions.

Oat, rye, and barley seedlings exhibited symptoms of injury identical with those observed in wheat. Corn also developed signs of injury that resembled those of the small grains.

The dry weights of tops of wheat plants were found to be inversely proportional to the logarithm of the magnesium-calcium ratio, between the limits 1.00 and 50.00 of this ratio.

An antagonistic effect of strontium toward magnesium was brought out clearly in this study. The addition of successively higher concentrations

of strontium was accompanied by a progressive increase in dry yield, until a maximum was reached; further increase in the concentration of strontium resulted in a reduction of yield due to the toxic action of the strontium.

DEPARTMENT OF BOTANY
COLUMBIA UNIVERSITY
NEW YORK CITY

Literature cited

Barton, L. V., and S. F. Trelease. 1927. Stimulation, toxicity, and antagonism of calcium nitrate and manganese chloride as indicated by growth of wheat roots. Bull. Torrey Bot. Club **54**: 559–577.

Eisenmenger, W. S. 1928. Toxicity, additive effects, and antagonism of salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club **55**: 261–304.

Garner, W. W., J. E. McMurtrey, C. W. Bacon, and E. G. Moss. 1923. Sand drown, a chlorosis of tobacco due to magnesium deficiency, and the relation of sulphates and chlorides of potassium to the disease. Jour. Agric. Res. **23**: 27–40.

———, J. E. McMurtrey, Jr., J. D. Bowling, Jr., and E. G. Moss. 1930. Magnesium and calcium requirements of the tobacco crop. Jour. Agric. Res. **40**: 145–168.

Gericke, W. F. 1922. "Magnesia injury" of plants grown in nutrient solutions. Bot. Gaz. **74**: 110–113.

Hansteen, B. 1910. Ueber das Verhalten der Kulturpflanzen zu den Bodensalzen. Jahrb. wiss. Bot. **47**: 289–376.

Loeb, J. 1906. The dynamics of living matter. New York.

Loew, O. 1892. Die Bedeutung der Kalk-Magnesiasalze in der Landwirtschaft. Landw. Versuchsst. **41**: 467–475.

———. 1903. The physiological rôle of mineral nutrients in plants. U. S. Dept. Agric. Bur. Plant Ind. Bull. 45: 1–70.

———, and D. W. May. 1901. The relation of lime and magnesia to plant growth. U. S. Dept. Agric. Bur. Plant Ind. Bull. 1: 1–53.

McCool, M. M. 1913. The action of certain nutrient and non-nutrient bases on plant growth. Cornell Univ. Agric. Exp. Sta. Memoir **2**: 113–216.

Osterhout, W. J. V. 1922. Injury, recovery, and death, in relation to conductivity and permeability. 259 p., 96 fig. Philadelphia: J. B. Lippincott Co.

Schaffnit, E., and M. Wieben. 1928. Untersuchungen über den Erreger der Federbuschsporenkrankheit *Dilophospora alopecuri* (Fr.) Fr. Forsch. auf dem Gebiet der Pflanzenkrankheiten und der Immunität im Pflanzenreich **5**: 5–38.

Shive, J. W. 1915. A study of physiological balance in nutrient media. Physiol. Res. **1**: 327–397.

Tottingham, W. E. 1914. A quantitative chemical and physiological study of nutrient solutions for plant cultures. Physiol. Res. **1**: 133–245.

Trelease, S. F. 1920. The relation of salt proportions and concentrations to the growth of young wheat plants in nutrient solutions containing a chloride. Philippine Jour. Sci. **17**: 527–600.

———, and B. E. Livingston. 1924. The relation of climatic conditions to the salt-proportion requirements of plants in solution cultures. Science **59**: 168–172.

———, and H. M. Trelease. 1924. Relation of seed weight to growth and variability of wheat in water cultures. Bot. Gaz. 77: 199–211.

———, and H. M. Trelease. 1925. Growth of wheat roots in salt solutions containing essential ions. Bot. Gaz. 80: 74–83.

———, and H. M. Trelease. 1926. Toxicity and antagonism in salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club 53: 137–156.

———, and H. M. Trelease. 1928. Susceptibility of wheat to mildew as influenced by salt nutrition. Bull. Torrey Bot. Club 55: 41–68.

Explanation of plates

PLATE 5

Fig. 1. Wheat plant exhibiting severe magnesium injury. Tillers have developed prematurely, and young leaves remain rolled. Series 2, culture 5. ×2.75.

Fig. 2. Early stage of magnesium injury, showing emergence of tightly rolled young leaf. Apical portion remains as stiff, wire-like structure. In many cases abscission of this leaf tip occurs. If injury is very severe, growth of the young leaf soon ceases. Injured fourth leaf of series 2, culture 4. ×2.75.

Fig. 3. Emergence of spiral from sheath. Spiral and rolled apical portion assume a drooping position. Fourth leaf of series 3, culture 4. ×2.75.

PLATE 6

Fig. 4. Spiral deformation, showing details of coil. Direction of coiling is reversed several times, with compact, irregular loops separating the more perfectly formed spiral regions. Fourth leaf of series 1, culture 5. ×7.0.

Fig. 5. Spirally distorted portion between tightly rolled apical and basal regions. Fourth leaf of series 3, culture 3. ×6.4.

Fig. 6. Leaf with two spirals. This type is rare. Fourth leaf of series 1, culture 5. ×2.2.

Fig. 7. Apex of fourth leaf emerging for short distance out of opening at the top of the sheath. Emergence of the lower part of the leaf has occurred through the side of the sheath. Series 2, culture 4. ×2.75.

PLATE 7

Fig. 8. Spiral in fourth leaf of series 1, culture 5. ×7.0.

Fig. 9. Leaf in which emergence of tightly rolled apex and spiral has been followed by rapid emergence and normal expansion of lower part. Fourth leaf of series 1, culture 5. ×3.5.

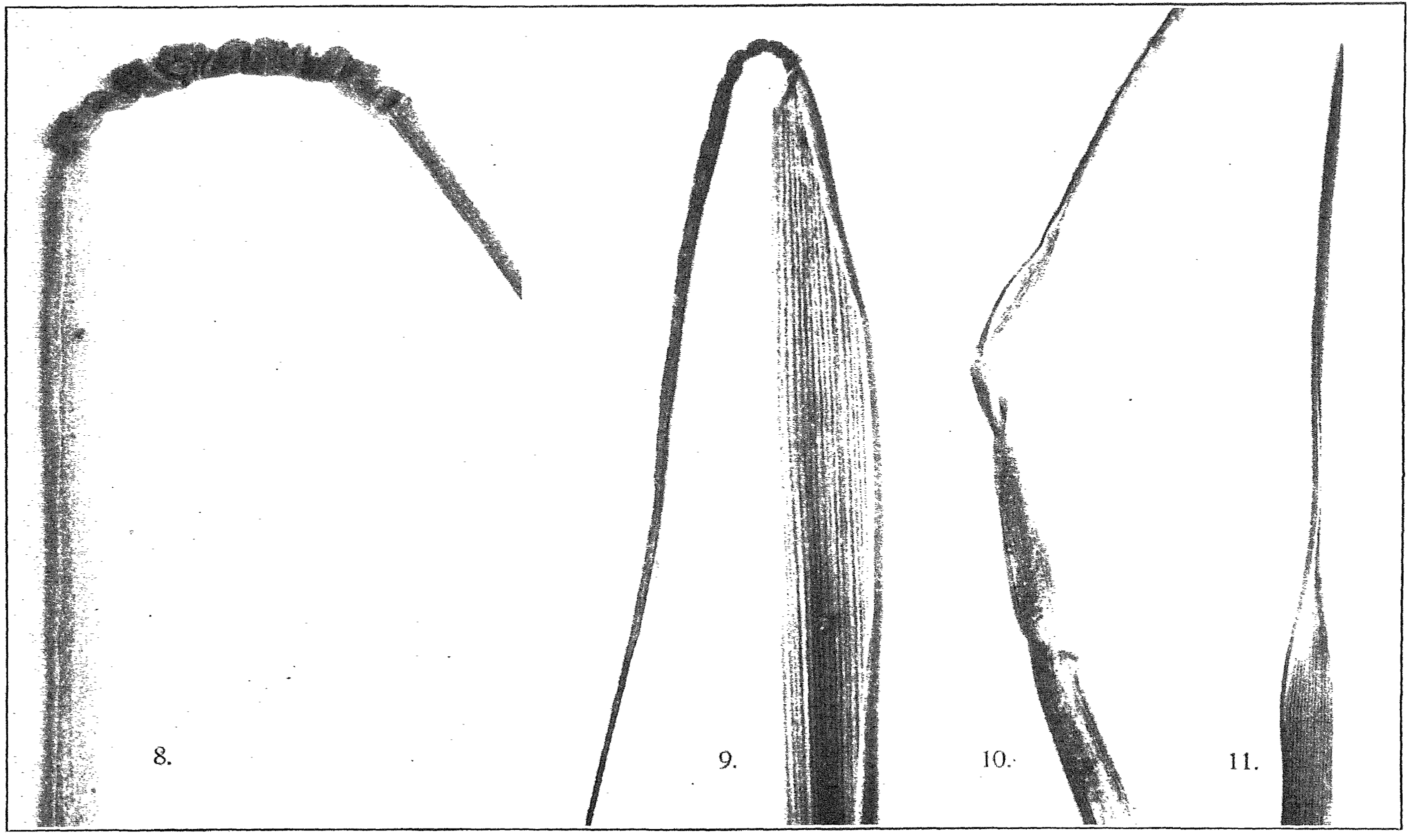
Fig. 10. Slightly injured leaf, showing long, loose spiral, with normally expanded lamina below. Marginal laceration extends to midrib. Fourth leaf of series 1, culture 3. ×2.2.

Fig. 11. Very slightly injured leaf. No spiral has been formed. Apex has remained tightly rolled, but rest of leaf has unrolled normally and has attained the usual length of healthy leaves. Fourth leaf of series 1, culture 4. ×2.2.

PLATE 8

Appearance of cultures of series 2 at time of harvesting. From left to right: Top row, cultures 8, 7, 6, and 5; bottom row, cultures 4, 3, 2, and 1. (Small numbers in photographs represent original culture numbers; to facilitate presentation of results the order has been reversed in this paper.) Decrease in size of plants (in passing from culture 1 to culture 8) is correlated with increase in value of magnesium-calcium ratio.


1.
2.
3.



TRELEASE AND TRELEASE: MAGNESIUM INJURY OF WHEAT

TRELEASE AND TRELEASE: MAGNESIUM INJURY OF WHEAT

Changes in root tips of wheat and corn grown in nutrient solutions deficient in calcium

RONALD BAMFORD

(WITH TWO TEXT FIGURES AND PLATES 9–13)

The rôle of the various mineral nutrients in plant growth has attracted the attention of investigators for over a century. Because of its pronounced effect on plant growth, calcium is one of the most interesting of the essential mineral elements. Many of the earlier workers recognized that the roots of plants grown in solutions deficient in calcium remain dwarfed, develop few lateral branches, and in time become badly discolored. On the other hand, if small quantities of this element are present in the culture solutions, these conditions do not appear or, at least, their appearance is greatly delayed. It is the purpose of this paper to report the results of a periodic examination of the cytological condition of root tips from corn (*Zea mays* L.) and wheat (*Triticum vulgare* Vill.) seedlings which were grown in solutions deficient in calcium. This study was made in an attempt to add to our knowledge concerning the function or physiological rôle of this element in the root cells of these plants.

The literature on the rôle of calcium in plant growth has been reviewed at frequent intervals. Loew (1899, 1901), Reed (1907), Warthiadi (1911), True (1922), Arrhenius (1926), Mevius (1927), and Farr (1927b) may be cited as among those who have presented extensive reviews of the literature.

Salm-Horstmar (1856) seems to have been the first to show the necessity of calcium for plant growth and the fact that it could not be replaced by magnesium. Stohmann (1862) demonstrated the necessity of calcium for the successful cultivation of corn plants, and shortly afterward Wolf (1864) noted that solutions of calcium salts accelerated root growth, in contrast with solutions of magnesium, potassium, ammonium, and sodium salts, which retarded it. Following these earlier investigations there were many speculations as to the function of this element in cellular metabolism. Holzner (1867) considered that it was necessary for the formation of cellulose, but later work by Mangin (1892) and others demonstrated that it was a constituent of the middle lamella of the cell wall. However, in a recent analysis of the cell walls in the meristematic regions of certain plants, by Tupper-Carey and Priestley (1923), calcium appears to be ab-

sent from the middle lamella, although they found it present in this part of the cell walls in the mature parts of the plant.

Boehm (1875), von Raumer and Kellerman (1880), and von Raumer (1883) considered its chief function as that of aiding in the transportation of the starch produced in photosynthesis. Groom (1896) claimed that carbohydrates were moved regardless of the presence of calcium in the tissues, though he considered that calcium compounds facilitated their movements. More recently, however, Maquenne and Demoussey (1922) have reported that calcium is the only element not necessary for the successful germination of pea seeds—a process in which the transportation of seed carbohydrates is essential.

Loew (1892, 1899, 1901) was perhaps the first to stress the essential nature of calcium for normal development in all the higher plants, although his hypothesis has not been accepted by many investigators. He concluded that calcium functions principally in two ways: (1) it combines with the proteins in the formation of nucleo-proteins, which take part in the construction of the nucleus, and (2) it neutralizes and precipitates the harmful acids in the cell sap, chief of which is oxalic acid. His second contention had been advanced previously by Schimper (1890). Warthiadi (1911), after a series of extensive observations on *Tradescantia*, agreed with Loew. Essentially the same explanation has been offered recently by Parker and Truog (1921). They found that high protein content accompanied high calcium content, and they assumed that the calcium neutralized an acid condition supposed to be brought about during the manufacture of these proteins. This theory has been severely criticized on the ground that fungi do not require calcium and still are able to produce large quantities of proteins and organic acids.

Although Boehm (1875) had noted that the toxicity of certain salts could be lessened by small quantities of calcium, Loew seems to have been the first worker to study this phenomenon extensively. He thought that the magnesium displaced calcium in parts of the protoplast when that element was absent from the culture solution; also that calcium took the place of magnesium when that was absent, with the result that phosphoric acid could not be transported. In either case the normal action of the cells was inhibited. Upon this he framed his well-known hypothesis of "the calcium-magnesium ratio," which stated that a specific ratio of calcium to magnesium was necessary for each type of plant, and that maximum development of the plant could only be reached when these elements were supplied in the optimum ratio. This hypothesis is still the subject of controversy, although the predominating evidence, aside from that furnished by Loew and his students, has been against the acceptance of it. McCool

(1913) and Lipman (1916) have presented summaries of the literature on this question. It is interesting to note that Haselhoff (1893), Molisch (1895), and Loew (1901) all believed that the toxicity of magnesium could be diminished by calcium but not by strontium and barium.

Kearney and Cameron (1902) and True and Geis (1903) were apparently among the first plant workers to recognize that the antidoting powers of nutritive elements were not confined to calcium. At this time the conception of antagonism and physiologically balanced solutions had been advanced by Loeb (1900) after his study on marine fishes. Shortly afterward Osterhout (1906, 1912) confirmed and extended Loeb's work by his extensive investigations on many forms of plants, including marine and freshwater algae, liverworts, and seed plants. In contrast with Loew's views that the function of calcium in reducing the toxicity of magnesium is an internal one, they considered that the important action of this element, along with many others, takes place at the surface of the protoplast. Antagonistic substances, present in a balanced solution, act upon the surface of the protoplast in such a way as to mutually retard the entrance of one another into the cell. Loeb (1911) stated that antagonistic salts may have a "tanning" effect on the surface films of cells, whereby these films acquire those physical qualities of durability and comparative permeability, without which the cell cannot exist. Osterhout's views, the results of many experiments, are summed up in his monograph (1922). He offers a detailed hypothesis of the mechanism of antagonistic action and shows that measurements of the electrical conductivity of tissues immersed in simple solutions enable one to predict what substances will antagonize each other and what degree of antagonism may be expected. Further indication of the surface effect of antagonistic ions was furnished by Hansteen (1910) when he grew a seedling in two different culture solutions by dividing the roots, and found that a plentiful supply of calcium from one solution did not reduce the toxic action upon the roots that were immersed in a simple solution of a magnesium salt. Although the principle had been emphasized much earlier by Loeb and Osterhout, McCool (1913) demonstrated clearly that antagonistic action was displayed by non-essential elements, such as strontium, barium, and sodium in the growth of crop plants; but calcium was the most effective of the elements that he tested. A valuable discussion of the literature on the subject of antagonism is offered by Stiles and Jorgensen (1914).

Another line of evidence as to the function of calcium is furnished by the work on the toxic action of distilled water. True (1914) observed that distilled water inhibited root growth even if the water contained no traces of toxic metallic salts. He found that when lupine seedlings were placed in

distilled water the electrolytic conductivity of the water increased. His explanation was that the distilled water brought about the dissociation of the electrolytes from their points of combination in the proteins. The loss of these electrolytes from the roots caused an increase of the conductivity of the water and was ultimately responsible for the death of the cells. He also found that if a calcium salt were added to the water in sufficient quantity to make a solution osmotically equal to tap water, then the leaching of electrolytes did not take place. Merrill (1915a, 1915b) came to similar conclusions concerning the conditions responsible for the increase in electrolytic conductivity, but claimed that the death of the cells was chiefly due to secondary factors that affected the cells in their starved condition. He was able to increase the exosmosis of electrolytes by treating the roots with various anesthetics for very short periods of time. Hibbard (1915) also found that the electrolytic conductivity of distilled water was increased by excretion from roots. He suggested that the death of the cells might be due to the toxicity of substances excreted by the roots into the culture solution. He used the extensive observations of the United States Department of Agriculture, initiated by Schreiner and Reed (1907), on toxic soils, to support his suggestion. Scarth (1924) offered another explanation of the toxicity of very pure distilled water. He considers the hydrogen-ion concentration of the water to be responsible, explaining that the acidity of the water is increased by dissolved carbon dioxide. It is interesting to note that calcium antagonizes this toxic action.

True and Bartlett (1912, 1915a, 1915b, 1916), after subsequent experiments, elaborated on True's original idea that calcium prevented the excretion of electrolytes from the roots of lupines. He also found that other cations, at certain concentrations, aided in preventing this loss of electrolytes. However, calcium was the most effective of these cations, regardless of whether in a one-, two-, or three-salt solution. In later papers (1921, 1922) True emphasized his conclusion that calcium is the most active agent in preventing leaching from the roots of lupines, and he suggested also that calcium plays an important part in cell wall formation and in the differentiation of tissues. He considered that the rôle of calcium in cell wall construction may even be linked with its action in preventing the toxic action of other elements upon the cell. Thus, he explained, as a result of experiments by Dr. Eckerson in his laboratory, that when calcium is absent from the culture solution, magnesium or potassium replaces the calcium of the middle lamella and forms magnesium or potassium pectate, thereby subjecting the cell to the toxic action of magnesium or potassium.

The evidence presented by various workers is conflicting, however, and no general hypothesis seems to explain all of the experimental data. For

example, Tuewa (1926) reported that when the hydrogen-ion concentration of the nutrient solution was kept at a pH value of seven or above, exosmosis did not occur. This seems to be in direct opposition to the observation of Prianischnikow (1923) that the injurious action of such acids as nitric or hydrochloric, in weak concentrations, could be reduced by the addition of a calcium salt, even though the hydrogen-ion concentration remained the same.

Brooks (1916), investigating the exosmosis in the dandelion peduncle, found, after testing the chlorides of calcium, sodium, and cerium, that calcium was the only cation which decreased the rate over very short periods of time. Osterhout (1923) employed the electrical resistance of the protoplasm to study the changes occurring in the protoplasm while active exosmosis was going on and concluded that active exosmosis indicated injury to the cell. Stiles and Jorgensen (1915, 1917) found that the more toxic the ions and the higher the concentration of those ions, the higher the rate of exosmosis.

True and Merrill both suggested that their methods of measurement by electrical conductivity did not take into account the non-electrolytic substances which might be excreted by the tissues and cells of the root. Very few observations have been made to determine the exact nature of all the excreted products, although many writers have assumed that some of the materials may be organic. Knop (1864) noted that seeds excreted both inorganic and organic substances into pure water. Similar observations were made by Hansteen (1894) and Puriewitsch (1897). Wächter (1905) obtained the exosmosis of sugar from onion scales after immersion in distilled water. He was able to reduce this if small amounts of potassium or sodium chloride were added to the water. On the other hand, ether treatment produced a greatly increased excretion which he attributes to the death of the cells. Lepeschkin (1906) was able to obtain similar results with *Pilobolus* spores. Hansteen Cranner (1922) made extensive analyses of the excreted substances from various types of cells and found that phosphatids made up the greater part of the organic substances excreted. This discovery led Hansteen Cranner to suggest that calcium compounds, since they seemed effective in reducing the quantity of the material excreted into the culture solutions, were active in coagulating the lipoid constituents of the protoplasm and thus were able to reduce the entrance of toxic agents. Stiles (1927) found that both organic and inorganic substances were discharged into distilled water from cubes of fleshy roots and tubers. He was able to reduce this excretion by aerating the medium and thought that these products may come from the injured cells on the cut surfaces. Recent investigations by Iljin (1928) on the exosmosis of carbohydrates

and potassium have served to emphasize the importance of calcium in controlling this process. He found that this element, whether in a one-, two-, or three-salt solution, was the most effective in reducing exosmosis.

Osterhout (1923) suggested that the greatest exosmosis, brought about by a toxic agent, probably occurs during the death of the cell. If this is so, we should expect to find organic as well as inorganic constituents among the excretion products. The whole question of the excretion of materials from cells has been considered in the literature from the standpoint that greater permeability of the membrane, regardless of what conception we may have of the structure of this membrane, causes increased exosmosis. Szücs (1912), however, doubts whether we should in general regard exosmosis as due to protoplasmic permeability, because in many cases the phenomena observed are not concerned with vital processes, but are the results of the death of the cells. Stiles (1924), after an excellent discussion of the literature on the subject, suggests that in some cases no change may take place in the membrane, but that complex and indiffusible substances may break down into simpler and diffusible ones. An interesting point to note in this connection is that neither Hansteen Cranner (1922) nor Iljin (1928) was able to get a protein test in their analyses of the substances excreted into culture solutions.

Not all the studies on exosmosis indicate that this process is such as to cause the death of the cells of the tissue involved. Merrill (1915a) reported that he was able to get seedlings to resume normal growth even after extended exposures to distilled water for twenty days, and Steward (1928), after protracted leaching experiments of forty-five days duration, found that slices of beet could form wound tissue, thus indicating that the cells, had remained in a semi-permeable condition throughout the experiment.

Direct observations on the effects of calcium on cell structure were first reported by Molisch (1895) on *Spirogyra*. Reed (1907) confirmed the findings of Molisch and observed that in the absence of calcium *Spirogyra* cells underwent nuclear division but cytokinesis failed and thus new cell walls were not formed. Similar observations were made on the root cells of *Zea mays*. He explains that the absence of new cell walls after mitosis in cells lacking calcium indicates that the cells were unable to form the fundamental 'middle layer' of the cell wall and, in consequence, no cell was formed. Loew (1899), in discussing Molisch's observations, offered a similar explanation. Hansteen Cranner (1914) reported that individual cells or rows of cells become separated from the surface of the root in the elongation zone, due to the dissolution of the cell wall in the absence of calcium. Later observations (1922), already mentioned, disclose that he changed his conception of the function of calcium. It should be pointed out

that Hansteen Cranner (1914, 1919, 1922, 1926) has always stressed the cell wall as an important factor in determining cell permeability. This conforms with his conception of the cell wall as being made up partly of protoplasmic infiltrations that are continuous with the cell protoplast.

Sorokin and Sommer (1929), in an intensive study of the root tip cells of *Pisum sativum* which were grown in culture solutions deficient in calcium, found that the death of the plants was associated with the degeneration of these meristematic cells. The degeneration was marked by the appearance of large vacuoles and the consequent decrease in the amount of cytoplasm. These changes disturbed mitotic division, with the result that pseudoamitotic and even typical amitotic division occurred. The abnormal divisions sometimes resulted in the formation of binucleated cells. The authors suggested that the deranged mitoses might be explained by assuming either that calcium is a necessary chemical constituent of the protoplast or that it is essential for the maintenance of the normal colloidal system of the cell. Day (1929), after an examination of the mature roots of the same species, reported that there were no signficant changes in the mature structure of the plants grown in solutions deficient in calcium.

Another conspicuous effect of calcium seems to be that of stimulating the growth of root hairs. Magowan (1908), Hansteen (1910), Coupin (1917) Kisser (1925), and Trelease and Trelease (1926a) all observed that in a single-salt solution containing calcium, dense growths of root hairs were formed, while in distilled water and in simple solutions lacking calcium few or no root hairs developed. Farr (1927a, 1927b, 1927c, 1928a, 1928b, 1928c) found that all calcium salts which he tested accelerated the growth of root hairs of Georgia collards, but that the anions of the salts were also important. All these results were produced with relatively weak concentrations of the salts. Addoms (1927) observed that if strong concentrations of calcium salts were used, the root hairs of wheat underwent radical protoplasmic changes within a few minutes. Toxic action was indicated by coagulation and flocculation of the protoplasm. Along similar lines Brink (1925) found that pollen tube growth was stimulated by the addition of suitable amounts of calcium salts to the culture media.

The relation of calcium salts to transpiration has received some attention. Burgerstein (1920, p. 97–105) has summarized much of the literature. While small amounts of various salts in mixed culture solutions may increase the rate of transpiration over that of plants in distilled water, this rate decreases when the total concentration becomes high. According to Reed (1910), Hansteen Cranner (1914), Chancerel (1914), and Kisser (1927) calcium salts in dilute simple solutions caused an increase in the transpiration rate. Meyer (1931), however, found that calcium salts, in the

concentrations he employed, retarded the transpiration of cotton plants. Iljin (1922) noted that calcium salts check the opening of the guard cells while potassium and sodium salts seem to stimulate this action. This suggests that calcium might be expected to lower the transpiring power of the plants.

The penetrability of the calcium ion into plant cells has received considerable attention, and the generally accepted view is that it enters plants much more slowly than many other ions—more slowly than potassium, sodium, nitrate, chloride, etc. Fitting (1915), Tröndle (1918), and Scarth (1925) have come to this conclusion. Osterhout (1910), however, has shown that it penetrates rapidly enough to permit a ready demonstration of its entrance. Stiles and Kidd (1919) have shown that it enters more rapidly at first than later, when an equilibrium tends to become established.

METHODS AND EXPERIMENTS

Wheat cultures. The culture methods employed in this study were essentially the same as those used by others working in this laboratory (Trelease and Trelease, 1925, 1926a, 1926b, 1928; Barton and Trelease, 1927; Eisenmenger, 1928; Cotton, 1930). A predetermined quantity of Marquis spring wheat (supplied by the University of Saskatchewan, crop of 1930) was soaked in distilled water for two hours and, after a thorough washing, transferred to culture dishes and germinated on wet filter paper until the primary roots were approximately six millimeters long. At this time selected seedlings were placed on paraffined bobbinet which was stretched over each of a number of enamelled iron pans filled with distilled water. Pyrex glass dishes were substituted for the enamelled pans after the first experiment. Each of these dishes was placed in a slightly larger dish, and the space between was filled with distilled water until the level of the water reached the top of the smaller dish containing the seedlings. During the first two days of growth a moist chamber was provided for the seedlings by placing a Pyrex glass cake dish on top of the smaller seedling dish. Two days after removing this glass cover, selected seedlings (the primary root measuring between 4.5 and 6 cm. and the tops between 6 and 7 cm.) were transferred to the culture solutions.

The culture vessels were cylindrical, glazed earthenware jars, obtained from the General Ceramics Company, having a capacity of about 7500 cc. Each jar was nearly filled with culture solution and then covered with a heavily paraffined Portland cement disk having five circular openings, in which were placed the paraffined cork stoppers that supported the plants. Each stopper bore either five or eight seedlings per culture jar. The cultures were kept on rotating tables (Shive, 1915) in the new roof green-

house of Columbia University, and they were therefore subjected to the same fluctuations in environmental conditions throughout the course of the experiment. Artificial light, controlled by a synchronous-motor time switch, was used to supplement daylight from 4 to 10 p.m., except during the first three weeks of the first experiment, which was started before the installation of the lights. When the wheat plants attained sufficient height, they were supported by means of wire loops that were attached to dowels, the lower ends of which were inserted into cork stoppers.

Corn cultures. A similar method was employed with the corn. Golden Eureka Dent corn (*Zea mays* L.) was soaked overnight, and after a thorough washing with distilled water it was germinated in the way described for wheat. When the roots were from one to two centimeters long, the seedlings were placed on paraffined wire netting which covered Pyrex dishes filled with distilled water. They remained there until the roots had attained a length of approximately 4.5 centimeters, and were then put in the culture solutions. One seedling was placed in each paraffined cork stopper, so that there were five plants per culture jar.

Nutrient solutions. In experiment 1, wheat (25 plants per culture) was grown in solutions of three different total concentrations, corresponding to two, one-half, and one-eighth atmospheres of osmotic pressure. These are designated series A, B, and C, respectively. The salts and their proportions are listed below.

	Series A	*Series B*	*Series C*
KH_2PO_4	.005 m	.00125 m	.0003125 m
K_2SO_4	.010 m	.00250 m	.0006250 m
NH_4NO_3	.005 m	.00125 m	.0003125 m
$CaCl_2$ and $MgCl_2$	.020 m	.00500 m	.0012500 m
Total	.040 m	.01000 m	.0025000 m

In each series the ratio of calcium to magnesium was varied from 100/0 to 0/100, as indicated in table 1, by means of eleven different solutions. A total of thirty-three different solutions was thus employed in experiment 1.

Observations and measurements of growth of the roots were recorded, and material was fixed for cytological study at the end of the first four days, at the end of seven days, and then weekly during the remainder of the time.

Experiment 2 was performed by Dr. Sam F. Trelease and through his kindness the writer was enabled to obtain material for cytological study. Corn plants were grown in solutions corresponding to approximately one-half an atmosphere of osmotic pressure. The salts used and their propor-

tions are listed below, while the ratios of calcium to magnesium are presented in table 1. Each of the nine different solutions was duplicated, making eighteen culture jars of plants.

KH_2PO_4	.002 m
NH_4NO_3	.002 m
K_2SO_4	.002 m
$CaCl_2$ and $MgCl_2$	.0025 to .005 m
Total	.0085 to .011 m

Material from this experiment was fixed at the end of twenty-five days.

Experiment 3 was undertaken to supplement the data secured from experiment 1. Wheat seedlings (40 per culture jar) were grown in a solution of the same composition and total concentration as in series B, experiment 1. The calcium and magnesium ratios are listed in table 1. Root tips from four plants were taken for fixation every two days throughout the duration of the experiment, which was two weeks.

TABLE 1

Ratio of calcium to magnesium

CULTURE NO.	EXP. 1.	EXP. 2.	EXP. 3.
1	100/0	63.6/36.4	2/98
2	98/2	50/50	1/99
3	95/5	36.4/63.6	.5/99.5
4	90/10	24.7/75.3	0/100
5	80/20	15.8/84.2	0/100*
6	50/50	9.8/90.2	80/20
7	20/80	5.7/94.3	—
8	10/90	3.5/96.5	—
9	5/95	2/98	—
10	2/98	—	—
11	0/100	—	—

* H_3BO_3, in a concentration of .000045 m, was added to this culture.

General cultural methods. To every culture $FeSO_4$ was added as a source of iron in a concentration of .00001 m. All culture solutions were changed regularly so as to give each wheat plant 60 cc. per day and each corn plant 100 cc. Temperature records and atmometer readings were kept for each of the experiments. These data are presented in table 2.

The hydrogen-ion concentration of the solutions in experiment 1 was taken after the renewal of the culture solutions and then again before the next renewal but no changes were recorded.

Cytological methods. The plant materials were fixed in Flemming's medium fluid and then infiltrated and imbedded by the usual xylol-par-

affin method. Sections were cut 10μ thick and stained with Flemming's triple and Haidenhain's iron-alum haematoxylin stains. The triple stain proved the more favorable for the material concerned.

TABLE 2

Experimental records

EXP.	DATE	TEMP. AVE.	TEMP. RANGE	AVE. DAILY EVAPORATION FROM ATMOMETER
Exp. 1	Oct. 27, 1930 to Dec. 1, 1930	19°C.	14°–25°C.	12.0 cc.
Exp. 2	Jan. 18, 1931 to Feb. 17, 1931	21°C.	18°–25°C.	21.1 cc.
Exp. 3	Feb. 22, 1931 to Mar. 9, 1931	22°C.	15°–27°C.	22.0 cc.

RESULTS

Gross effects

Throughout the experiments special attention was paid to the roots of the plants which were grown in the solutions deficient in calcium—those from which calcium was absent and those in which the content of calcium was low in proportion to that of magnesium. Only brief reference to the tops will be made in this paper, since the investigation was primarily concerned with the roots.

TABLE 3

Average length and dry weight of roots in experiment 1

CULTURE NO.	AVE. ROOT LENGTH IN CM.			AVE. DRY WEIGHT OF ROOTS IN MGM.		
	Series A	Series B	Series C	Series A	Series B	Series C
1	20.4	32.3	22.2	15.0	18.6	18.2
2	21.3	20.4	18.2	19.8	15.4	16.2
3	19.4	19.6	17.2	17.7	14.8	15.3
4	21.5	22.2	17.7	19.4	15.8	15.9
5	20.7	21.6	17.5	21.3	20.0	14.1
6	19.9	21.4	18.1	23.2	19.7	18.7
7	20.9	26.3	18.7	22.0	18.5	19.7
8	22.3	22.9	19.1	24.0	19.9	16.9
9	19.3	24.8	19.7	18.0	18.7	16.5
10	17.5	24.7	16.7	17.1	20.4	15.9
11	5.5	5.7	5.7	4.0	5.3	7.0

Wheat. The root lengths and dry weights of roots of the wheat plants of experiment 1 are presented in table 3, and they are shown graphically in figures 1 and 2. The most obvious feature of both of these figures is the steep slope at the extreme right end of each curve. This indicates a great increase in root growth when the proportion of calcium in the culture solution is increased from 0 to 2 or 5 per cent of the total concentration of calcium and magnesium. Thus we notice that when calcium is absent, the

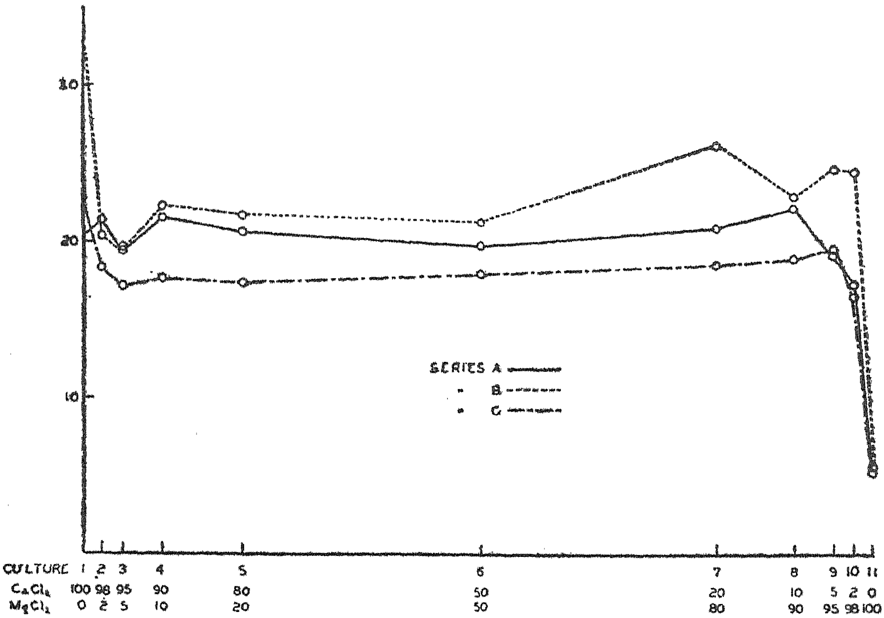


Fig. 1. Average length of primary wheat roots from fifteen plants grown in culture solutions of three different total concentrations.

The ordinates represent growth in centimeters and the abscissas the ratios of calcium to magnesium in each solution of the three different total concentrations.

values for root length and dry weight are very low; but when calcium and magnesium are in a ratio of 5/95, the root lengths and dry weights are practically as great as those obtained with much higher proportions of calcium to magnesium. In fact, the root growth is nearly the same throughout the wide range of proportions of calcium to magnesium lying between 5/95 and 98/2. It is interesting to note that a marked rise in the curves for root length and dry weight occurs when magnesium was absent from the solutions of series B and C (medium and low total concentrations of salts).

Although the experiment was carried on for five weeks, the seminal roots attained their maximum length in approximately two weeks; but the

lateral roots of most of the plants continued to develop throughout the entire period. Rough measurements taken periodically, when fixations were made, showed this to be true.

Frequent observations showed that the roots of the plants in solution 11 (Ca/Mg = 0/100) of each series remained the same as at the beginning as far as length was concerned. Between the ratio values for solution 11 (0/100) and that for solution 9 (5/95) there seems to be a definite critical

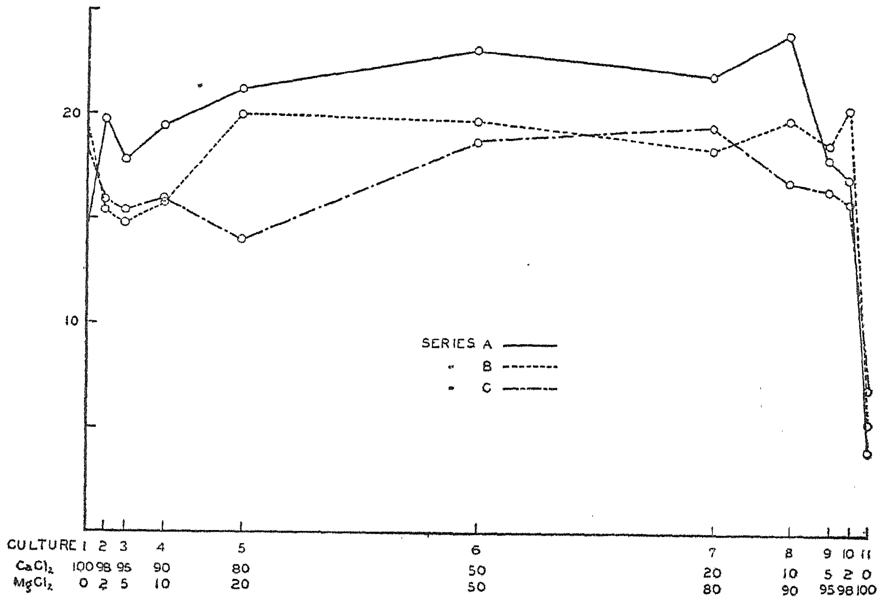


Fig. 2. Average dry weight of wheat roots from fifteen plants grown in culture solutions of three different total concentrations.

The ordinates represent the dry weights in milligrams and the abscissas the ratios of calcium to magnesium in each solution of the three total concentrations.

range of ratio values, within which the growth in length of roots is markedly influenced by the ratio of calcium to magnesium.

A few days after the experiment began, the roots of the plants grown in solution 11 of each series, besides having made no measureable growth, were slightly discolored, crooked, and devoid of lateral branches. Also, the original five seminal or primary roots of each plant had been supplemented by a number of new adventitious roots. At the end of a week the roots were badly discolored, very brittle, crooked, and still devoid of lateral roots. The new adventitious roots soon developed the same symptoms of abnormality that were exhibited by the older roots. Each root tip at this time

had become covered with a hyaline droplet of liquid of a viscid nature; the droplets adhered so closely that they could not be removed by shaking the plants. Microscopic examination showed the droplets to be composed of homogeneous gelatinous material, but it indicated nothing regarding their origin—whether due to gelatinization of cell walls, to exudation of materials from the root cells, or to fungus or bacterial action upon the roots. Soon after the droplets were first noticed, the culture solutions began to exhibit a slight turbidity. Throughout the remainder of the experiment there was no noticeable outward change in the roots except that they became soft and flabby, in contrast with their brittle nature at the end of the first week.

In solution 10 of each series (Ca/Mg = 2/98) the plants developed normally for the first few days. They produced many lateral root branches, although not so abundantly as in cultures 1–9, which had higher and more favorable ratios of calcium to magnesium. The seminal roots and their lateral branches in this solution increased almost as rapidly in length as those of the plants in solutions with higher calcium-magnesium ratios. All of the roots retained their normal white appearance for more than a week. However, at the end of about ten days the tip of each seminal root had been surpassed in length by an abundance of lateral roots that had elongated more rapidly than the main root; this indicated clearly an injurious action of the culture solution upon the root system. The tips of the seminal roots at this time exhibited a slight brownish discoloration, they were crooked, and they had the general appearance of the root tips in the solutions from which calcium was totally absent. Later in the period of the experiment these pathological symptoms became more pronounced, and the tips of some of the older lateral roots developed symptoms of injury that were similar to those first apparent in the apices of the main roots.

The roots of plants grown in solution 9 (Ca/Mg = 5/95) of each total concentration were very similar in their development to those in solution 10, except that the characteristic forms of injury did not become evident till after four weeks of growth in the solution. The growth in length of the seminal roots in this solution was practically the same as that of the roots in solutions having much higher proportions of calcium to magnesium.

The root systems of cultures 1–8 (Ca/Mg ratio varying from 100/0 to 10/90) made healthy and rapid development and exhibited no significant pathological symptoms. They were all essentially alike in rate of growth and in external appearance. Even the roots in culture 1, supplied with a solution containing no magnesium, were not visibly different from those of the remainder of the good cultures. In fact, with the medium and low total concentration of salts (1/2 and 1/8 atm.) greater root growth occurred in

solution 1 than in the solutions containing the lower concentrations of calcium; this surprising result seems to deserve further investigation. No clearly defined optimum solution for root growth is apparent among those tested in this study. Growth is so nearly the same throughout the wide range of proportions of calcium to magnesium, from 100/0 to 5/95, that the average of a very large number of plants would need to be employed in order to determine accurately the optimum solution for root growth. In a general way, the graphs of figures 1 and 2 indicate that 1/8 atm. (series C) is least favorable among the three total concentrations tested; while with most Ca/Mg ratios 1/2 atm. (series B) is most favorable by the criterion of root elongation and 2 atm. (series A) is most favorable on the basis of dry weight of roots. When the growth of tops is taken into consideration, all the lower ratios of calcium to magnesium (Ca/Mg values from 20/80 to 0/100) are distinctly inferior to the higher ratios, and it may be provisionally concluded that solution 5 (Ca/Mg = 80/20) with a total concentration of salts equivalent to 1/2 atm. represents the best of the solutions employed in this study.

The data secured in experiment 3 serve to supplement those of the first experiment. The results were essentially the same in the two experiments. Observations demonstrated that as the calcium was reduced between 2 per cent and 0 per cent of the total concentration of calcium and magnesium there was a pronounced decrease in root elongation and likewise in the number of lateral roots that were produced. The root tips of the plants in these solutions deficient in calcium took on the same general appearance as that described previously, and the culture solutions again became cloudy at the time that small viscid droplets appeared on the root tips. The roots that were supplied with a solution containing a small quantity of boron in addition to the usual constituents did not differ from those which lacked boron. It is interesting to note that even in solution 3, in which the ratio of calcium to magnesium was only $\frac{1}{2}/99\frac{1}{2}$, there was a small increase in root length and some development of laterals, whereas root growth was entirely inhibited in the solution from which calcium was absent.

During the course of experiment 3 several attempts were made to bring about the recovery of roots that had been injured by immersion for short periods of time in complex culture solutions devoid of calcium; the injured roots were transferred to similar solutions containing calcium, and their subsequent condition was studied. But these trials were all unsuccessful. The injured roots never recovered; instead, new adventitious roots or laterals developed, which continued to grow and thus served to establish new growing apices. It became evident that even if plants were kept

for only one day in a complex culture solution from which calcium was absent, the tips of the seminal roots were permanently injured.

Other observations demonstrated that the roots were not significantly injured by immersion for relatively long periods (four to seven days) in distilled water, which of course supplied no calcium. It is evident therefore that the rapid injury which occurred when calcium was omitted from the complex culture solutions could not have been due merely to the failure of this solution to supply calcium to the roots. It must have resulted from the unbalanced condition of the culture solution, the components of which were toxic when not antagonized by calcium.

Corn. Although periodic observations were not made during the course of experiment 2, with corn, the roots at the end of twenty-five days, when fixations were made, resembled those of the wheat plants that had been grown in similar solutions. In solutions 8 and 9 of this experiment, in which the proportion of calcium to magnesium was very low, the root tips were crooked and exhibited a brownish discoloration. The lateral roots had elongated more rapidly than the primary roots and almost covered the tips of the latter. The total number of the lateral roots, however, was much smaller than in the better solutions.

Cytological effects

The cytological investigation, like the study described in the preceding section of this paper, was mainly concerned with the root tips of the plants grown in the culture solutions in which the ratio of calcium to magnesium was so low that root growth was greatly diminished. It has already been pointed out that unless the Ca/Mg ratio was reduced to a very low value, the root growth was not materially retarded. In a general way it may also be said that the cytological study, to be reported here, has shown that the cell structure of the root tips does not seem to be significantly altered except under similar conditions of relatively great calcium deficiency.

All observations recorded here were made of median sections in the apical region of the seminal roots. It is this part of the root, of course, which is fundamentally concerned with initial cell division and enlargement. Description of observations on cellular structure can best be presented by constant reference to the figures of plates 9–13.

Wheat. The results of experiments 1 and 2, on wheat, will be considered together, because of the similarity of the observations pertaining to them. In figure 1 of plate 9 there is shown a section of a young wheat root tip which had grown for four days in distilled water at the beginning of one of the experiments. This section illustrates the appearance of all root tips at

the time of immersion in the culture solutions. Nuclei and cytoplasm are normal, and active mitosis is going on. The conditions represented by this section were maintained throughout the active growth period of roots that were kept in solutions in which the calcium content was relatively high. As the activity of the root tip lessened, the merisematic region was reduced, dividing cells were less prevalent, and the cytoplasmic content was decreased, until finally the root apex became non-functional.

If the calcium content of the solution were low, but if calcium were not entirely absent (for example, with solution 1, experiment 3), the root tips, as far as the prepared slides indicated, underwent no pathological changes during the first few days, and sometimes none were apparent even after a week. Then, clear, non-stainable regions gradually made their appearance in the cytoplasm. These hyaline regions resemble vacuoles, though their mode of origin is probably quite different from that of the vacuoles which normally form in enlarging cells. They appear to arise by a process of erosion, possibly involving a hydrolytic dissolution of the cytoplasm. Finally the remaining cytoplasm came to occupy a peripheral position adjacent to the cell wall, so that the tip gave the appearance of being destitute of practically all contents except nuclei (fig. 2, pl. 9). The nuclei did not seem to be affected while these changes were taking place in the cytoplasm. A few cells from the developing metaxylem strand of the section (fig. 12, pl. 13) illustrate this condition.

In sharp contrast with this gradual loss of stainable contents is the change that occurred in cells of the root tips in solutions entirely lacking calcium (fig. 3, pl. 9). Even after two days, and at the most four, the protoplast had become badly disorganized. The cytoplasm of cells in this condition is shrunken and usually deeply stained, while the nucleus is a heterogeneous mass which cannot be differentially stained (fig. 16, pl. 13).

Regardless of whether the process was one of quick disorganization, as in the case of the roots in solutions totally devoid of calcium, or gradual, as was observed when some calcium was present, the cell contents eventually were reduced until they finally disappeared—or at least became non-stainable by the ordinary methods of cytological technique. The cytoplasm always was the first part of the cell to be affected; after it had become a neglibible quantity in the cell, a deep staining body, the former nucleus, still persisted as a heterogeneous mass. Soon thereafter the nucleus disappeared, leaving nothing visible but the cell walls. The nucleus, like the cytoplasm, thus became either totally disintegrated or so modified as to lose its attraction for cytological stains.

The cells of the epidermis and the cortex were the first to show the changes described above, and accordingly, the cells of these regions were

the first to lose their stainable contents (fig. 4, pl. 10). Later the vascular cylinder underwent the same modifications, until sometimes only the central metaxylem strand was left with its protoplasmic contents (fig. 5, pl. 10). The final result was always the same. The root tip in this stage resembled the line drawings so often found in text books (fig. 6, pl. 10). The cell walls have apparently retained their former shape, even though the cells lack their usual protoplasmic contents. It has already been noted that the roots became very brittle soon after immersion in calcium-deficient solutions; this brittleness perhaps indicates some change in the cell walls which accounts for their rigidity and prevents their collapse. The process of degeneration has occurred without any conspicuous pathological modification of cell size and form, and the arrangement of the tissues is not evidently different from that in the normal root. In fact, this method of treating roots might be recommended as a useful one for securing clear outlines of cells and tissues, unobscured by protoplasmic contents. Soon after the cell contents had disappeared from the whole apex, or in some cases earlier, fungi and bacteria began to attack and destroy the root tip. Sterile cultures would be helpful in any further study of these phenomena.

It was very interesting to observe the condition of the lateral roots, in the cultures in which they were produced, while the tips of the seminal roots that bore them were undergoing these changes. In many cases the tip of the main root became covered with a crown-like growth of apparently normal lateral roots. Numerous elongated lateral branches arose near the end of the seminal root and surpassed it in length. Sections of this material showed the main tip to be in a state of degeneration, in many cases being empty of cellular contents, and yet the lateral branches, especially the youngest, were in every way normal. Some of the older branches degenerated and later lost their contents. It seems probable that a further study over longer periods of time would reveal a series of progressive changes similar to those observed in the tips of the seminal roots.

Cells that were undergoing mitosis at the time of immersion in the low-calcium solutions seemed to be the most resistant to this process of disorganization which results in a loss of cellular contents. In the cortical region of some root tips, where the majority of the cells had lost their stainable contents, cells such as that illustrated in figure 15 of plate 13 have occasionally been observed. In this case the cells on every side had become vacant except one, and that contained only the remains of a nucleus. A cell of this sort might readily remain in the binucleated condition, if it were unable, owing to cytoplasmic disorganization, to complete the process of cell wall formation. As a result, two nuclei would be left within the confines of the mother cell wall. Binucleated cells have actually been

observed in some root tips, though they seem to be comparatively rare.

In the solutions totally lacking calcium many constricted root tips were observed. These constrictions did not seem to be confined to any particular place; in some cases they were just a few microns from the end, and in others behind the meristematic region. The cellular condition of such tips always was similar to that illustrated in figure 3 of plate 9.

Corn. The results obtained with corn were similar in all respects to those secured with wheat, in so far as the experiments with the two plants were comparable. Thus the observations on the corn confirm those on wheat, and they greatly strengthen the idea that these phenomena may be of rather general occurrence among different kinds of plants. It should be recalled that all fixations of the tips of the primary roots of corn were made at the same time, and that none of the solutions were totally devoid of calcium although some had very low concentrations of this element.

In solutions having a high concentration of calcium all tissues of the root tips presented a normal appearance (fig. 7, pl. 11), essentially like that of wheat roots in similar physiologically balanced solutions. The condition of the cellular contents was typical of that of healthy roots in general. This may be illustrated by the normal condition of the cells of one of the metaxylem strands (fig. 11, pl. 13).

On the other hand, the roots in solutions low in calcium presented a very different appearance. In an incipient stage of degeneration all of the cells of the root tip contained nuclei, although these were far from normal in appearance, and the cells were deficient in cytoplasm (fig. 8, pl. 11). A closer examination of some of the metaxylem cells of this tip shows that there remained in the cells small quantities of stainable material besides the nuclei. A more advanced phase of injury was characterized by a further loss of protoplasmic contents; the epidermal and cortical cells of a root in this condition were empty, while cells of the vascular cylinder still retained some nuclear and cytoplasmic remnants (fig. 9, pl. 12; fig. 14, pl. 13).

Finally, in solutions of very low calcium content, we may find root tips similar to those found in wheat in which the cell contents are almost entirely absent and the usual line drawing appearance is presented (fig. 10, pl. 12). In those few cells which were not empty the protoplasmic contents were limited to a much reduced nucleus (fig. 13, pl. 13).

It should be mentioned that the constriction of the root tips and the quick destruction of the protoplasts, as observed in wheat, were not seen in the experiment with corn. This is probably due to the fact that all the solutions for corn contained some calcium. Attacks of fungi and bacteria were evident after the corn roots had passed the final stage represented in figure 10 of plate 12. As in wheat, numerous lateral branches developed near

the severely injured apices of the roots; and to all appearances these branches remained normal for some time after the main apex had died.

DISCUSSION

The results reported in the preceding section of this paper demonstrate clearly that when the complex culture solutions employed in this study were deficient in calcium the cells of the meristematic region of the root tips of both wheat and corn underwent profound changes, which resulted in a marked reduction or, in many cases, a complete loss of stainable cell contents. The beginning of these changes was manifested by a gradual erosion or dissolution of the cytoplasm, and the process continued until finally, in severe cases of injury, there was a complete disappearance of the cytoplasmic contents of the cells—or at least a transformation of the cytoplasm into unstainable products. Accompanying this disintegration of the cytoplasm, but somewhat slower in its progress, was the similar change observed in the nucleus. This cellular component at first appeared to show no alteration, but later it became transformed into a disorganized body which took a dark stain and failed to exhibit any differentiated structure. Although this body persisted longer than the cytoplasmic remains, it gradually became smaller and its ultimate fate was the same as that of the cytoplasm; its final disappearance left the cell totally devoid of stainable contents.

In the early stages of the cytoplasmic changes described above, clear regions appeared within the cell. Sorokin and Sommer (1929), who observed similar changes in the cells of the root tips of *Pisum sativum*, considered that these hyaline regions were produced by a process of vacuolization. But it seems doubtful whether the change observed in the root tips of the present study should be regarded as comparable to the true vacuolization which occurs when the normal cell is enlarging during the absorption of water. The meristematic cells were not increasing in volume during the formation of the hyaline regions. The boundaries between these regions and the cytoplasm were more irregular than those of normal vacuoles. Moreover, the hyaline regions continued to develop progressively while the stainable contents simultaneously diminished. In the last stages before the complete disappearance of the cell contents, small portions of cytoplasm were left irregularly distributed in various parts of the cell. The large clear area of the cell at this time in many cases extended to parts of the cell wall and bore little or no resemblance to a normal vacuole.

The changes here involved seem to indicate some process of erosion which disintegrates the protoplast. The process is suggestive of a hydrolytic dissolution resembling autolysis. Thus the hyaline regions left in the

cell probably contain at first the dissolved products of the protoplasm, rather than the usual constituents of the cell sap that would be in vacuoles. Later they may contain only water, since the cell wall is generally readily permeable to solutes and it may be supposed that these dissolved materials gradually diffuse out of the cells—into the surrounding culture medium and possibly into other portions of the roots.

Death of the cells undoubtedly occurred before the final disappearance of stainable contents. This was evidenced by the failure of cells exhibiting incipient injury to recover after the roots had been transferred to physiologically balanced solutions. Death probably took place at a rather early stage in the process of cytoplasmic disintegration, although further study would be needed to determine the death point with any high degree of precision. Tests of plasmolysis and recovery and of the entrance of stains to which living cells are impermeable might be useful in this connection.

The occurrence of pronounced injury and consequent protoplasmic disintegration appeared to be definitely related to the calcium content of the culture solutions employed in this study. The injury was limited to a critical range of Ca/Mg ratios which lay between 0/100 and 5/95. In these toxic solutions the calcium salt made up from 0 to 2.5 per cent of the total molecular concentration of all the salts. The critical range was the same for series A of experiment 1 as for series C, although the actual concentrations of calcium in series A were sixteen times as great as in series C. This furnishes convincing evidence that the ratio of calcium to magnesium, or the ratio of calcium to all of the other components of the solution, rather than the absolute concentration of calcium, was the factor which determined the occurrence of injury. The rate and severity of injury in the toxic solutions were inversely proportional to the ratio of calcium to magnesium, or to the ratio of calcium to the other constituents of the solution. With the solutions lacking calcium the action was such that permanent injury occurred soon after the immersion of the roots; but when small quantities of calcium were present, the injury was delayed for a period of time which depended upon the calcium content of the solution. These conclusions are based on the cytological appearance of root sections, the rate of growth, and the final length and dry weight of the seminal roots.

When calcium was entirely absent from the complex culture solutions, root growth ceased almost immediately and the series of degeneration changes within the cells progressed rapidly. But in distilled water, which of course lacks calcium, the growth of seedling roots continued for a number of days. Such roots elongated considerably and produced lateral branches. While this growth was taking place, the cellular condition of the root apices exhibited no significant abnormalities. If calcium is assumed to

be a necessary cellular constituent, we must suppose that sufficient quantities of this element for considerable growth of the seminal roots were derived from the material stored within the seed. The immediate cessation of root growth in the complex solutions lacking calcium must therefore be attributed to the physiologically unbalanced nature of these solutions, rather than to their failure to supply calcium. In the absence of calcium the other constituents of the culture solution, especially magnesium, were present in sufficient concentration to be poisonous to wheat roots (Trelease and Trelease, 1926a).

Although the present experiments were planned with reference to variations in the Ca/Mg ratios of the solutions, it should be emphasized that the influence of these solutions on the plants undoubtedly depended upon the complex balance of the culture solutions. If other basic solutions had been employed, the relations of the plants to the Ca/Mg ratios might have been quite different from those obtained in this study. A more nearly complete study would of course involve the use of many more culture solutions, in which all components were varied systematically. Throughout this paper the results have been discussed in their relations to the ratio of calcium to magnesium in the solutions that were used. Considering the manner in which the solution components were varied, the results might be interpreted in more general terms with reference to the ratio of calcium to all of the other constituents of the solutions.

The disintegration of the cell contents that occurred in root tips subjected to toxic solutions must have resulted in soluble products that were able to diffuse out of the injured cells, presumably into the culture solution as well as into other cells of the root. With the dissolution of the protoplast, particularly the cytoplasm, the semi-permeability of the cell must have been destroyed, thus releasing the various soluble materials derived from the former protoplast.

The bearing of this process on the numerous studies of exosmosis, leaching, and excretion, as the phenomena have been variously termed in the literature, is obvious. Probably many of the extreme cases of exosmosis are not due to changes in permeability of living cells, but rather to post-mortal changes and excretions due to the destruction of the protoplast of the cell. This might be especially true where anesthetics, acids, etc., have been used to increase the permeability or where nutrient solutions lacking calcium have been employed (True, 1916, Iljin, 1928), thus allowing the various constituents of the solutions to be poisonous. Osterhout (1923), by means of electrical resistance measurements of the protoplast, has shown this to be true in the case of *Nitella* when chloroform is applied.

It is recognized that many studies have shown that exosmosis occurs

even when roots are immersed in distilled water. In fact, the excretion of materials from roots has been used to demonstrate the so-called toxicity of distilled water. It has also been shown that low concentrations of a calcium salt have an inhibitory effect on such excretion. But even more rapid exosmosis than that occurring in distilled water has been found to take place when unbalanced solutions, lacking calcium, are employed. Cases of this kind may probably be explained as due to an actual destruction of the protoplasts, such as was observed in the present study.

The work of Wächter (1905), Hansteen Cranner (1910, 1914, 1919, 1922, 1926), True (1914, 1915a, 1915b, 1916), Merrill (1915a, 1915b), Hibbard (1915), Stiles and Jorgensen (1915), Brooks (1916), Iljin (1928), Steward (1928), and many others has shown that the products of exosmosis, under a variety of conditions and with various kinds of tissues as well as with roots, may be electrolytes, sugars, lipoids, etc. If such a disorganization of the protoplast as that described here occurs in some of these cases, we should expect to find the soluble forms of all the substances which go to make up an aggregate protoplasm. It is strange that protein seems to be lacking in the exudates from plant cells undergoing exosmosis; at least it has never been reported. Although the protoplasm includes a variety of proteins, it is possible that the proteins are completely converted into soluble products, such as amino acids, and thus the culture solutions containing the exuded products may not give the ordinary tests for protein.

The turbidity observed in the culture solutions during the course of these experiments did not seem to coincide with the time of the disorganization of the protoplasm. It did not become conspicuous until several days after the cell changes had taken place. This suggests that the action of bacteria and fungi on the disorganized roots or on their exuded products may have been the causal factor. Wächter (1905), Merrill (1915a), and Steward (1928) have reported that the solutions did not become turbid if precautions were taken to sterilize them. On the other hand, Hansteen Cranner (1922) concluded that the turbidity observed in his cultures was due to the presence of insoluble lipoids derived from the protoplast, especially from the part which he regarded as infiltrating the cell wall and being responsible for the maintenance of normal permeability in the cell. He considered that their loss involved a destruction of this condition of permeability.

Certain effects of calcium deficiency on the meristematic regions of the higher plants have been previously reported by Reed (1907) in the root tips of *Zea mays*, Warthiadi (1911) in the apical meristem of *Tradescantia*, and Sorokin and Sommer (1929) on the root tips of *Pisum sativum*. They all report cell changes, but not the complete disintegration of the

protoplasm that was observed in this investigation. Since the meristematic regions of the root apex seem to be the first parts affected, it is probable that many cases of dwarfed plants reported in the literature can be explained as due to injury to these parts resulting from calcium-deficient solutions. Less severe injury may not prevent the formation of mature tissues. Thus, it has been reported by Day (1929) that the mature regions of the root were normal, even though the plants were dwarfed. She did not investigate the root tips.

The failure of the cell walls to collapse after the destruction of the protoplast in the injured tips suggests that some change was induced in these structures as well as in the cell contents. The nature of this change could only be ascertained by chemical tests, since microscopic examination revealed no visible modification of the walls. Albrecht and Davis (1929) found difficulty in preparing sections of soy-bean stems when the plants had suffered from calcium starvation, and they suggested that this indicated some change in the structure of the cell walls.

SUMMARY

The influence of calcium-deficient solutions upon the growth and cytological structure of the root tips of young wheat and corn seedlings is reported in this paper.

In such solutions the cells of the root apex gradually lost all their stainable contents. The cell walls remained intact, so that the final appearance of the meristematic root apex was comparable to that of a line drawing in a text book.

The cytoplasm was affected first. It seemed to undergo a gradual erosion, suggestive of hydrolytic dissolution, until it completely disappeared. During the early changes in the cytoplasm the nucleus remained normal but eventually it degenerated into a heterogeneous mass and finally disappeared.

This process of protoplasmic disintegration first affected only the peripheral layers of the cells in the epidermal and cortical regions. Later it progressed to the interior and finally upward in the roots.

It seems probable that many of the extreme cases of exosmosis reported in the literature, especially those which follow treatment with toxic agents, are due to protoplasmic disintegration, rather than merely to changes in the permeability of living cells.

In the present experiments the occurrence of pronounced injury was correlated with the ratio of calcium to magnesium in the culture solution, or with the ratio of calcium to all the other components of the solution. It was independent of the absolute concentration of calcium. Marked in-

jury, resulting in a total loss of cell contents, did not occur when the Ca/Mg ratio was 5/95 or higher, or when the concentration of the calcium salt was 2.5 per cent or more of the total molecular concentration of the solution.

Growth ceased almost immediately after immersion of a root in a complex culture solution from which calcium was excluded. Through a rather definite critical range the rate of root growth was roughly proportional to the calcium content of the solution or to the ratio of calcium to magnesium.

No lateral roots developed when calcium was entirely absent from the culture solution. When small amounts were present, the lateral roots continued to elongate after growth of the main root had ceased.

The pronounced injury that occurred in complex solutions deficient in calcium appeared to be due to the physiologically unbalanced nature of these solutions. In the absence of sufficient calcium, the other constituents of the culture solution, especially magnesium, were highly toxic to the cells of the roots.

The writer wishes to acknowledge his indebtedness and appreciation to Doctor Sam F. Trelease for his valuable suggestions, criticisms, and constant interest during the progress of this work.

Department of Botany
Columbia University
New York City

Literature cited

Addoms, R. M. 1927. Toxicity as evidenced by changes in the protoplasmic structure of root hairs of wheat. Amer. Jour. Bot. **14**: 147–165.

Albrecht, W. A., and F. L. Davis. 1929. Physiological importance of calcium in legume inoculation. Bot. Gaz. **88**: 310–321.

Arrhenius, O. 1926. Kalkfragen, Bodenreaktion und Pflanzenwachstum. 148 p. Leipzig.

Barton, L. V., and S. F. Trelease. 1927. Stimulation, toxicity, and antagonism of calcium nitrate and manganese chloride as indicated by growth of wheat roots. Bull. Torrey Bot. Club **54**: 559–577.

Boehm, J. 1875. Über dem vegetablischen Nährwerth der Kalksalze. Sitzungsb. d. Wien Akad. d. Wiss. **71**: 287–304.

Brink, R. A. 1925. The influence of hydrogen-ion concentration on the development of the pollen tube of the sweet pea (*Lathyrus odoratus*). Amer. Jour. Bot. **12**: 149–162.

Brooks, S. C. 1916. Studies on exosmosis. Amer. Jour. Bot. **3**: 483–492.

Burgerstein, A. 1920. Die Transpiration der Pflanzen. II. 264 p. Jena.

Chancerel, L. 1914. Le rôle du calcium dans la végétation forestière. Rev. Gen. Bot. **25**: 83–89.

Cotton, M. 1930. Toxic effects of iodine and nickel on buckwheat grown in solution cultures. Bull. Torrey Bot. Club **57**: 127–140.

Coupin, H. 1917. Influence des sels de calcium sur les pois absorbants des racine. Compt. Rend. **164**: 641–643.

Day, D. 1929. Some effects of calcium deficiency on *Pisum sativum*. Plant Physiol. **4**: 493–506.

Eisenmenger, W. S. 1928. Toxicity, additive effects, and antagonism of salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club **55**: 261–305.

Farr, C. H. 1927a. Studies on the growth of root hairs in solutions. I. The problem, previous work, and procedure. Amer. Jour. Bot. **14**: 446–456.

————. 1927b. Studies on the growth of root hairs in solutions. II. The effects of the concentration of calcium nitrate. Amer. Jour. Bot. **14**: 497–515.

————. 1927c. Studies on the growth of root hairs in solutions. III. The effect of centration of $CaCl_2$ and $Ca(OH)_2$. Amer. Jour. Bot. **14**: 553–565.

————. 1928a. Studies on the growth of root hairs in solutions. IV. The pH-molar rate relations for collards in calcium chloride. Amer. Jour. Bot. **15**: 6–32.

————. 1928b. Studies on the growth of root hairs in solutions. V. Root hair elongation as an index of root development. Amer. Jour. Bot. **15**: 103–114.

————. 1928c. Studies on the growth of root hairs in solutions. VI. Structual responses to toxic pH and molar concentrations of calcium chloride. Amer. Jour. Bot. **15**: 171–179.

Fitting, H. 1915. Untersuchungen über die Aufnahme von Salzen in die lebende Zelle. Jahrb. Wiss. Bot. **56**: 1–64.

Groom, P. 1896. Preliminary note on the relation between calcium and the conduction of carbohydrates in plants. Ann. Bot. **10**: 91–96.

Hansteen, B. 1894. Ueber die Ursachen der Entleerung der Reservestoffe aus Samen. Flora **79**: 419–429.

————. 1910. Über das Verhalten der Kulturpflanzen zu den Bodensalzen. Jahrb. Wiss. Bot. **47**: 289–376.

Hansteen Cranner, B. 1914. Über das Verhalten der Kulturpflanzen zu dem Bodensalzen. III. Beiträge zur Biochemie und Physiologie der Zellwand lebender Zellen. Jahrb. Wiss. Bot. **53**: 536–599.

————. 1919. Beiträge zur Biochemie und Physiologie der Zellwand und der plasmatischen Grenzschichten. Ber. Deut. Bot. Ges. **37**: 380–391.

————. 1922. Zur Biochemie und Physiologie der Grenzschichten lebender Pflanzenzellen. Meldinger Norges Landsbruheiskole. **2**: 1–160.

————. 1926. Untersuchungen über die Frage ob in der Zellwand losliche Phosphatide vorkommen. Planta **2**: 438–445.

Haselhoff, E. 1893. Versuche über den Ersatz des Kalks durch Strontian bei der Pflanzenernährung. Landw. Jahrb. **22**: 851–870.

Hibbard, R. P. 1915. The question of the toxicity of distilled water. Amer. Jour. Bot. **2**: 389–401.

Holzner, G. 1867. Ueber die physiologische Bedeutung des oxalsauren Kalkes. Flora **50**: 497–525.

Iljin, W. S. 1922. Wirkung der Kationen von Salzen auf den Zerfall und die Bildung von Stärke in den Pflanzen. Biochem. Zeitschr. **132**: 494–510.

————. 1928. Durchlässigkeit des Protoplasmas, ihre quantitative Bestimmung und ihre Beeinflussung durch Salze und durch die Wasserstoffionenkonzentration. Protoplasma **3**: 558–602.

Kearney, T. H., and F. K. Cameron, 1902. Some mutual relations between alkali soils and vegetation. U. S. Dept. Agric. Rep. **71**: 1–78.

Kisser, J. 1925. Ueber das Verhalten von Wurzeln in feuchter Luft. Jahrb. Wiss. Bot. **64**: 416–439.

————. 1927. Untersuchungen über den Einfluss der Nährsalze auf die Wasserabgabe, Wasseraufnahme, relative Spross- und Wurzelmasse und die Blattstruktur. Planta **3**: 562–577, 578–596.

Knop, W. 1864. Untersuchungen über die Aufnahme der Mineralsalze durch das Pflanzengewebe. Landw. Versuchs-stat. **6**: 81–107.

Lepeschkin, W. W. 1906. Zur Kenntnis des Mechanismus der aktiven Wasserausscheidung der Pflanzen. Beih. z. Bot. Centralbl. **19**: 409–452.

Lipman, C. B. 1916. A critique of the hypothesis of the lime-magnesia ratio. Plant World **19**: 83–105, 119–135.

Loeb, J. 1900. On ion-proteid compounds and their role in mechanics of life phenomena. I. Poisonous character of a pure NaCl solution. Amer. Jour. Physiol. **3**: 327–338.

————. 1911. The role of salts in the preservation of life. Science **34**: 653–665.

Loew, O. 1892. Ueber die physiologischen Functionen der Calcium- und Magnesiumsalze im Pflanzenorganismus. Flora **75**: 368–394.

————. 1899. The physiological role of mineral nutrients. U. S. Dept. Agric. Div. Veg. Physiol. and Path. Bull. 18: 1–60.

————. 1901. Liming of soils from a physiological standpoint. U. S. Dept. Agric. Bur. Pl. Ind. Bull. 1: 9–35.

Magowan, F. N. 1908. The toxic effect of certain common salts of the soil on plants. Bot. Gaz. **45**: 45–49.

Mangin, L. 1892. Étude historique et critique sur la presence des composés pectiques dans les tissue végétaux. Jour. Bot. **6**: 12–19.

Maquenne, L., and E. Demoussey. 1922. Influence du calcium sur l'utilization des réserves pendant la germination des graines. Compt. Rend. **175**: 249–252.

Merrill, M. C. 1915a. Some relations of plants to distilled water and certain toxic solutions. Ann. Missouri Bot. Gard. **2**: 459–506.

————. 1915b. Electrolytic determinations of exosmosis from the roots of plants subjected to the action of various agents. Ann. Missouri Bot. Gard. **2**: 507–57?.

McCool, M. M. 1913. The action of certain nutrient and non-nutrient bases on plant growth. Cornell Agric. Exp. Sta. Mem. **2**: 121–216.

Mevius, W. 1927. Kalk-ion und Wurzelwachstum. Jahrb. Wiss. Bot. **66**: 183–253.

Meyer, B. S. 1931. Effects of mineral salts upon the transpiration and water requirements of the cotton plant. Amer. Jour. Bot. **18**: 79–93.

Molisch, H. 1895. Die Ernährung der Algen. Sitzungsb. Wien Akad. d. Wiss. **104**: 783–800.

Osterhout, W. J. V. 1906. On the importance of physiologically balanced solutions for plants. Bot. Gaz. **42**: 127–134.

————. 1910. On the penetration of inorganic salts into living protoplasm. Zeitsch. f. physik. Chem. **70**: 408–413.

————. 1912. The permeability of protoplasm to ions and the theory of antagonism. Science **35**: 112–115.

————. 1922. Injury, recovery, and death, in relation to conductivity and permeability. 259 p. J. B. Lippincott Co., Philadelphia and London.

————. 1923. Exosmosis in relation to injury and permeability. Jour. Gen. Physiol. **5**: 709–725.

Parker, F. W., and E. Truog. 1921. The relation between the calcium and the nitrogen content of plants and the function of calcium. Soil Sci. **10**: 49–55.

Prianischnikow, D. 1923. Zur Frage über die Bedeutung des Calciums für die Pflanzen. Ber. Deut. Bot. Ges. **41**: 138–144.

Puriewitsch, K. 1897. Physiologische Untersuchungen über die Entleerung der Reservestoffbehälter. Jahrb. Wiss. Bot. **31**: 1–69.

Raumer, E. von. 1883. Kalk und Magnesia in der Pflanze. Landw. Versuchs-stat. **19**: 253–280.

————, **and C. Kellerman.** 1880. Ueber die Function des Kalks im Leben der Pflanze. Landw. Versuchs-stat. **25**: 25–38.

Reed, H. S. 1907. The value of certain nutritive elements to plant cells. Ann. Bot. **21**: 501–543.

————. 1910. The effect of certain chemical agents upon the transpiration and growth of wheat seedlings. Bot. Gaz. **49**: 81–109.

Salm-Horstmar, F. zu. 1856. Versuche und Resultate über die Nahrung der Pflanzen. 39 p. Diss. Braunschweig.

Scarth, G. W. 1924. The toxic action of distilled water and its antagonism by cations. Trans. Roy. Soc. Canada **18**: 97–104.

————. 1925. The penetration of cations into living protoplasm. Amer. Jour. Bot. **12**: 133–148.

Schimper, A. F. W. 1890. Zur Frage der Assimilation der Mineralsalze durch die grüne Pflanze. Flora **73**: 207–278.

Schreiner, O., and H. S. Reed. 1907. The production of deleterious excretions by roots. Bull. Torrey Bot. Club **34**: 279–303.

Shive, J. W. 1915. A study of physiological balance in nutrient media. Physiol. Res. **1**: 327–397.

Sorokin, H., and A. L. Sommer. 1929. Changes in the cells and tissue of root tips induced by the absence of calcium. Amer. Jour. Bot. **16**: 23–39.

Steward, F. C. 1928. The maintenance of semi-permeability in the plant cell during leaching experiments. Proc. Leeds Phil. Soc. **1**: 258–270.

Stiles, W. 1924. Permeability. 292 p. Wheldon and Wesley, London.

————. 1927. The exosmosis of dissolved substances from storage tissues in water. Protoplasma **2**: 577–601.

————, **and I. Jorgensen.** 1914. The antagonism between ions in the absorption of salts by plants. New Phytol. **13**: 253–268.

————, **and I. Jorgensen.** 1915. Studies in Permeability. I. The exosmosis of electrolytes as a criterion of antagonistic ion-action. Ann. Bot. **29**: 349–367.

————, **and I. Jorgensen.** 1917. Studies in permeability. IV. The action of various organic substances on the permeability of the plant cell, and its bearing on Czapek's theory of the plasma membrane. Ann. Bot. **31**: 47–76.

————, **and F. Kidd.** 1919. The comparative rate of absorption of various salts by plant tissues. Proc. Roy. Soc. London **B 90**: 487–504.

Stohmann, F. 1862. Über einige Bedingungen der Vegetation der Pflanzen. Ann. d. Chem. und Pharm. **121**: 285–338.

Szücs, J. 1912. Experimentelle Beiträge zu einer Theorie der antagonischen Ionenwirkung. Jahrb. Wiss. Bot. **52**: 85–142.

Trelease, S. F., and H. M. Trelease. 1925. Growth of wheat roots in salt solutions containing essential ions. Bot. Gaz. **80**: 74–83.

————, **and H. M. Trelease.** 1926a. Toxicity and antagonism in salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club **53**: 137–156.

————, **and H. M. Trelease.** 1926b. Relation of temperature to the physiological value of salt solutions as indicated by growth of wheat roots. Bull. Torrey Bot. Club **53**: 605–609.

———, and **H. M. Trelease.** 1928. Susceptibility of wheat to mildew as influenced by salt nutrition. Bull. Torrey Bot. Club **55**: 41–68.

Tröndle, A. 1918. Sur la perméabilité du protoplasme vivant pour quelques sels. Arch. sci. phys. et nat. **45**: 38–54, 117–132.

True, R. H. 1914. The harmful action of distilled water. Amer. Jour. Bot. **1**: 255–273.

———. 1921. The function of calcium in the nutrition of seedlings. Jour. Amer. Soc. Agron. **13**: 91–107.

———. 1922. The significance of calcium for the higher plants. Science **55**: 1–6.

———, and **H. H. Bartlett.** 1912. Absorption and excretion of salts by roots as influenced by concentration and composition of culture solutions. U. S. Dept. Agric. Bur. Pl. Ind. Bull. **231**: 1–36.

———, and **H. H. Bartlett.** 1915a. The exchange of ions between the roots of *Lupinus albus* and culture solutions containing one nutrient salt. Amer. Jour. Bot. **2**: 255–278.

———, and **H. H. Bartlett.** 1915b. The exchange of ions between the roots of *Lupinus albus* and culture solutions containing two nutrient salts. Amer. Jour. Bot. **2**: 311–331.

———, and **H. H. Bartlett.** 1916. The exchange of ions between the roots of *Lupinus albus* and culture solutions containing three nutrient salts. Amer. Jour. **3**: 47–57.

———, and **W. J. Geis.** 1903. On the physiological action of some of the heavy metals in mixed solutions. Bull. Torrey Bot. Club **30**: 390–402.

Tuewa, O. T. 1926. Zur Frage der Exosmose der Kationen aus der Wurzeln. Bull. Inst. rech. biol. Univ. Perm. **4**: 479–492. (Ref. Bot. Centralbl. N. S. **9**: 142, 1927.)

Tupper-Carey, R. M., and J. H. Priesley. 1923. Composition of the cell wall in the apical meristem of the stem and root. Proc. Roy. Soc. London **B 95**: 109–131.

Wachter, W. 1905. Untersuchungen über den Austritt von Zucker auf den Zellen der Speicheorgan von *Allium cepa* und *Beta vulgaris*. Jahrb. Wiss. Bot. **41**: 165–220.

Warthiadi, D. 1911. Veränderungen der Pflanze unter dem Einfluss von Kalk und Magnesia. 154 p. Diss. Munich.

Wolf, W. 1864. Die Saussure'schen Gesetze der Aufsaugung von einfachen Salzlösungen durch die Wurzeln der Pflanzen. Landw. Versuchs-stat. **6**: 203–230.

Explanation of plates

The photomicrographs were taken with the aid of a Bausch & Lomb 16 mm. objective and a 7.5× compensating ocular, the resulting magnification being 140×. The figures in plate 5 were drawn with a camera lucida, using a Zeiss 2 mm. apochromatic objective and a 10× compensating ocular. The resulting magnification was about 1400×.

Plate 9

Median longitudinal sections of wheat root tips after:

Fig. 1. Four days in distilled water. Representative of the condition of all root tips at the time of immersion in the culture solutions. Roots in solutions of high calcium content retained this normal appearance throughout the active growth period of the terminal roots.

Fig. 2. Seven days in a culture solution with a calcium-magnesium ratio of 2/98. There is a marked reduction of cytoplasm in the cells, but the nuclei are not markedly affected thus far.

Fig. 3. Two days in a culture solution with a calcium-magnesium ratio of 0/100. The complete absence of calcium was always associated with rapid shrinkage and disintegration of the protoplasts.

PLATE 10

Median longitudinal sections of wheat root tips after:

Fig. 4. Two weeks in a culture solution with a calcium-magnesium ratio of 2/98. The cells of the cortical and epidermal regions of the root have lost their stainable contents.

Fig. 5. One week in a culture solution with a calcium-magnesium ratio of 0/100. The only cells retaining their cytoplasmic contents are those of the developing central metaxylem strand.

Fig. 6. Two weeks in a culture solution with a calcium-magnesium ratio of 2/98. This condition is representative of the condition finally reached by all the roots in solutions very low in calcium. Cell contents have entirely disappeared.

PLATE 11

Median longitudinal sections of corn root tips after 25 days:

Fig. 7. In a culture solution with a high calcium-magnesium ratio (63.6/36.4). Presents normal appearance of healthy root.

Fig. 8. In a culture solution with a much lower calcium-magnesium ratio (3.5/96.5) The cytoplasmic contents of the cells are greatly reduced, although each cell exhibits the remains of a nucleus.

PLATE 12

Median longitudinal sections of corn root tips after 25 days:

Fig. 9. In a culture solution with a very low calcium-magnesium ratio (2/98). The cells of the epidermis and cortex are devoid of protoplasmic contents.

Fig. 10. In the same culture solution as the root tip of figure 9. Nearly all the cells are devoid of protoplasmic contents.

PLATE 13

Fig. 11. Cells from a metaxylem strand of the root tip of corn illustrated in figure 7.

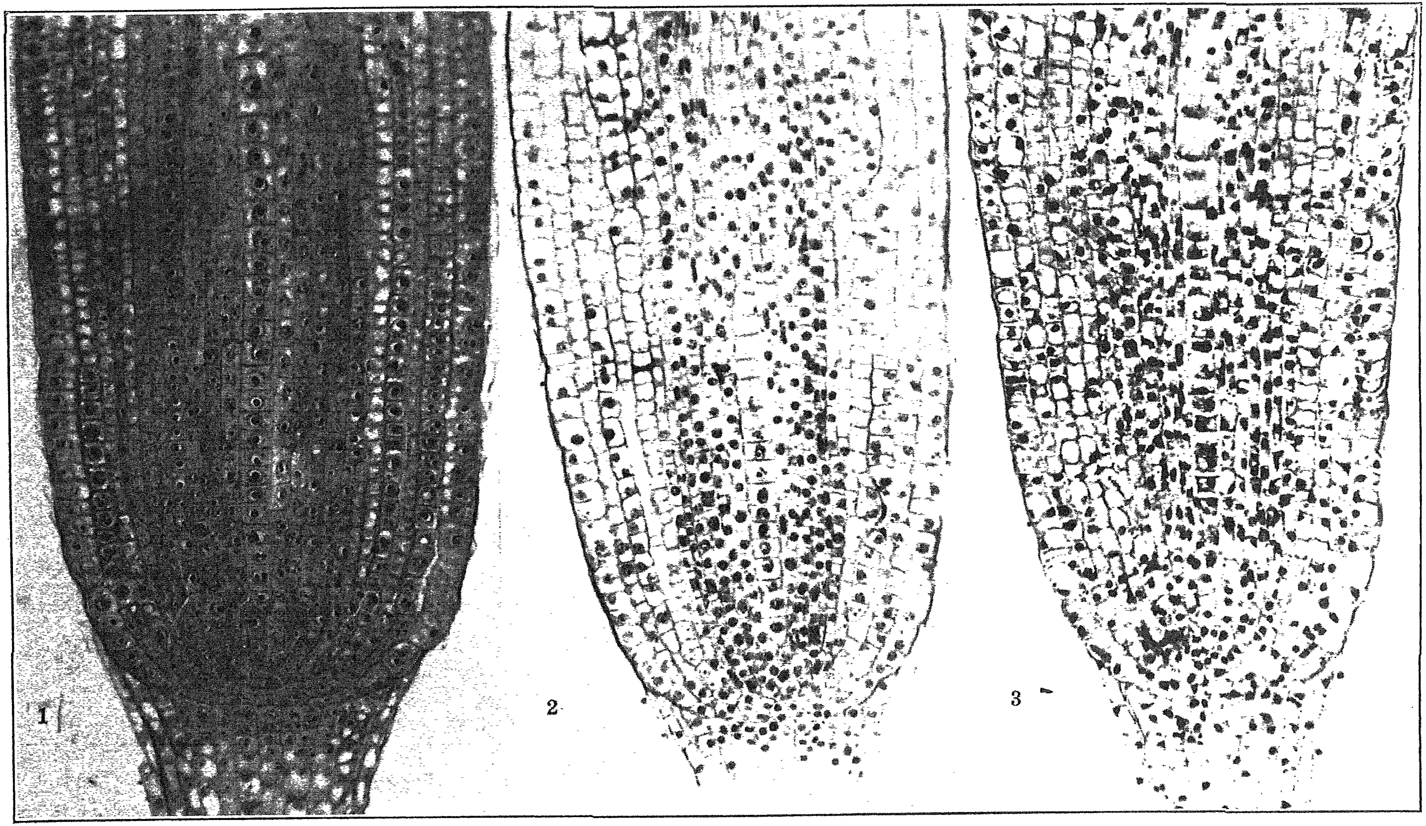
Fig. 12. Cells from the developing metaxylem strand of the wheat root tip represented in figure 2. The nuclei appear normal, but erosion of the cytoplasm has left a hyaline region in the cell.

Fig. 13. Cells from a metaxylem strand of the root tip of corn shown in figure 10. The majority of the cells in this section were empty, and this drawing illustrates the last stage before the complete disappearance of the contents.

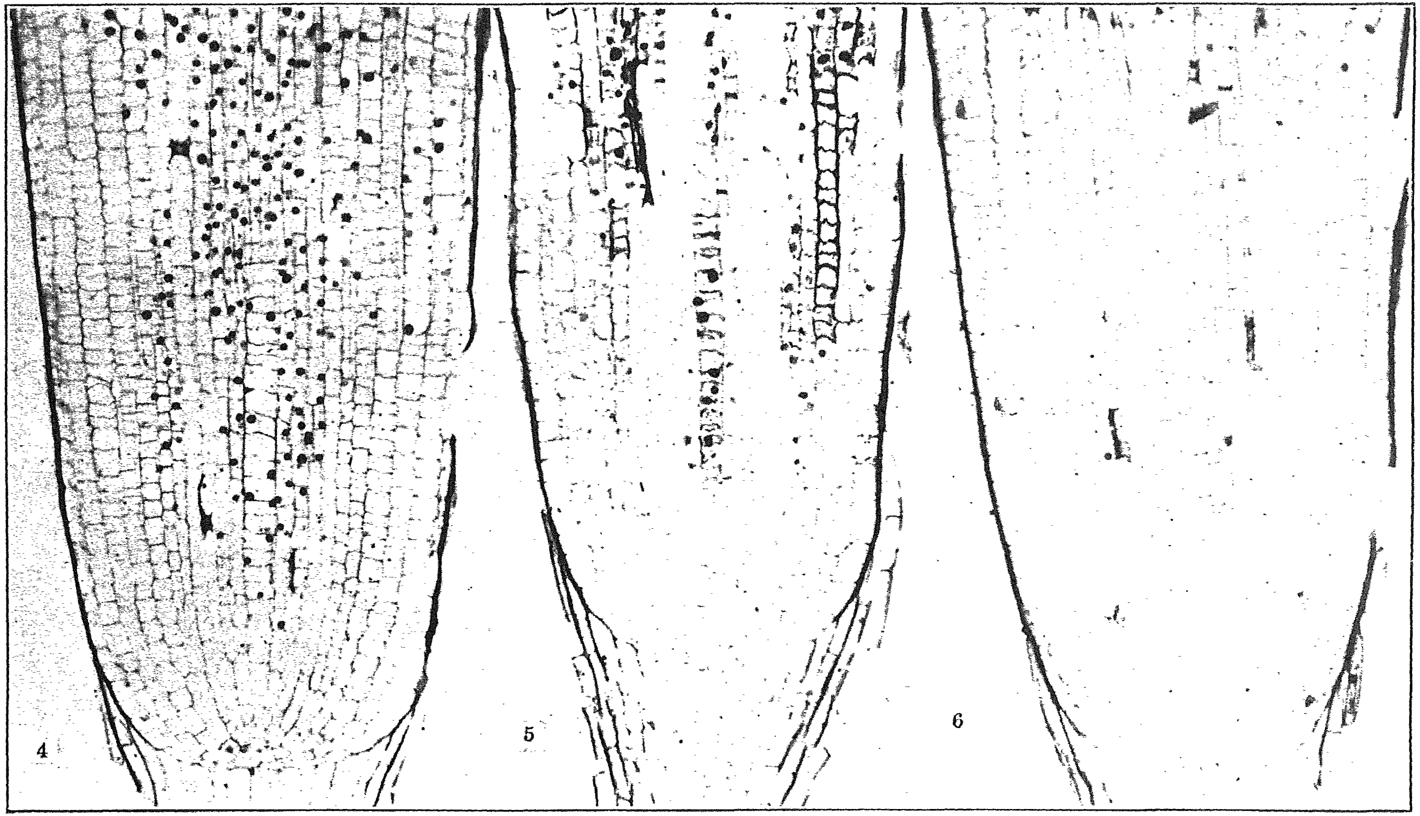
Fig. 14. From the root tip of figure 9, showing the complete disintegration of the protoplast. The hyaline regions in these cells are not typical of vacuoles.

Fig. 15. A cell from the cortical region of a root tip that has almost completed division. All the surrounding cells were empty with the one exception which is figured. The persistance of cytoplasm in a cell undergoing mitosis is significant.

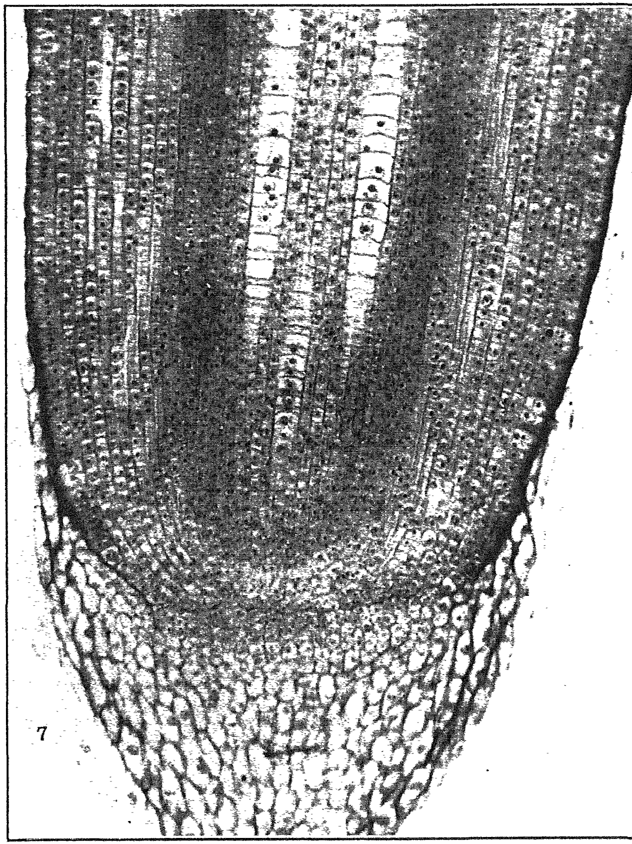
Fig. 16. Cells from a metaxylem strand of a root tip illustrated in figure 3. This shrunken and degenerate condition is typical of the cells of roots that had been placed for a short time in a solution destitute of calcium.



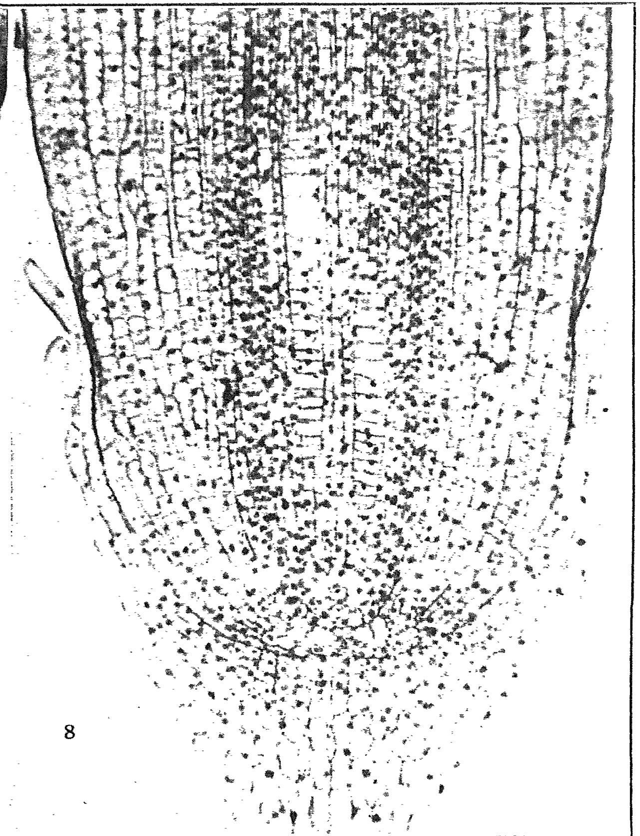
BAMFORD: CHANGES IN ROOT TIPS



BAMFORD: CHANGES IN ROOT TIPS

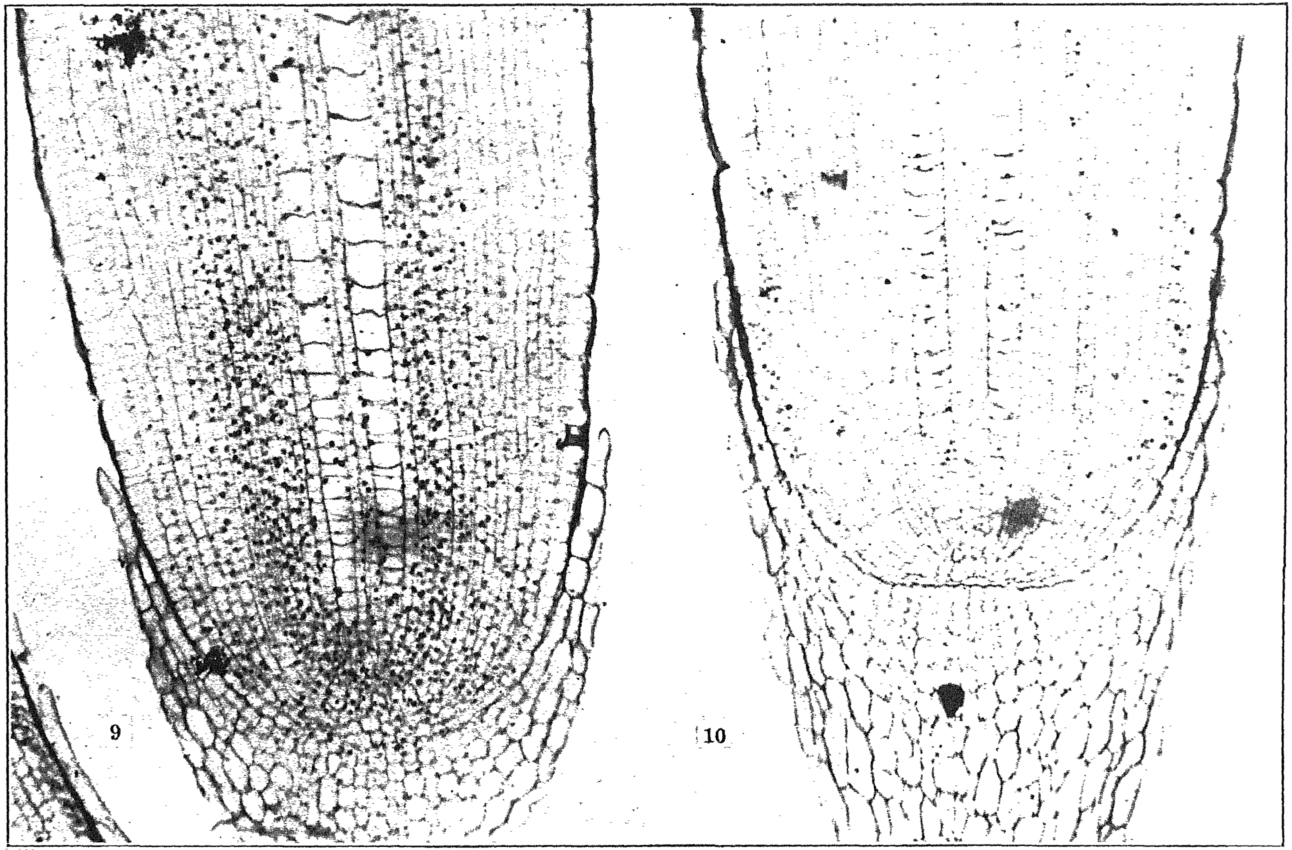


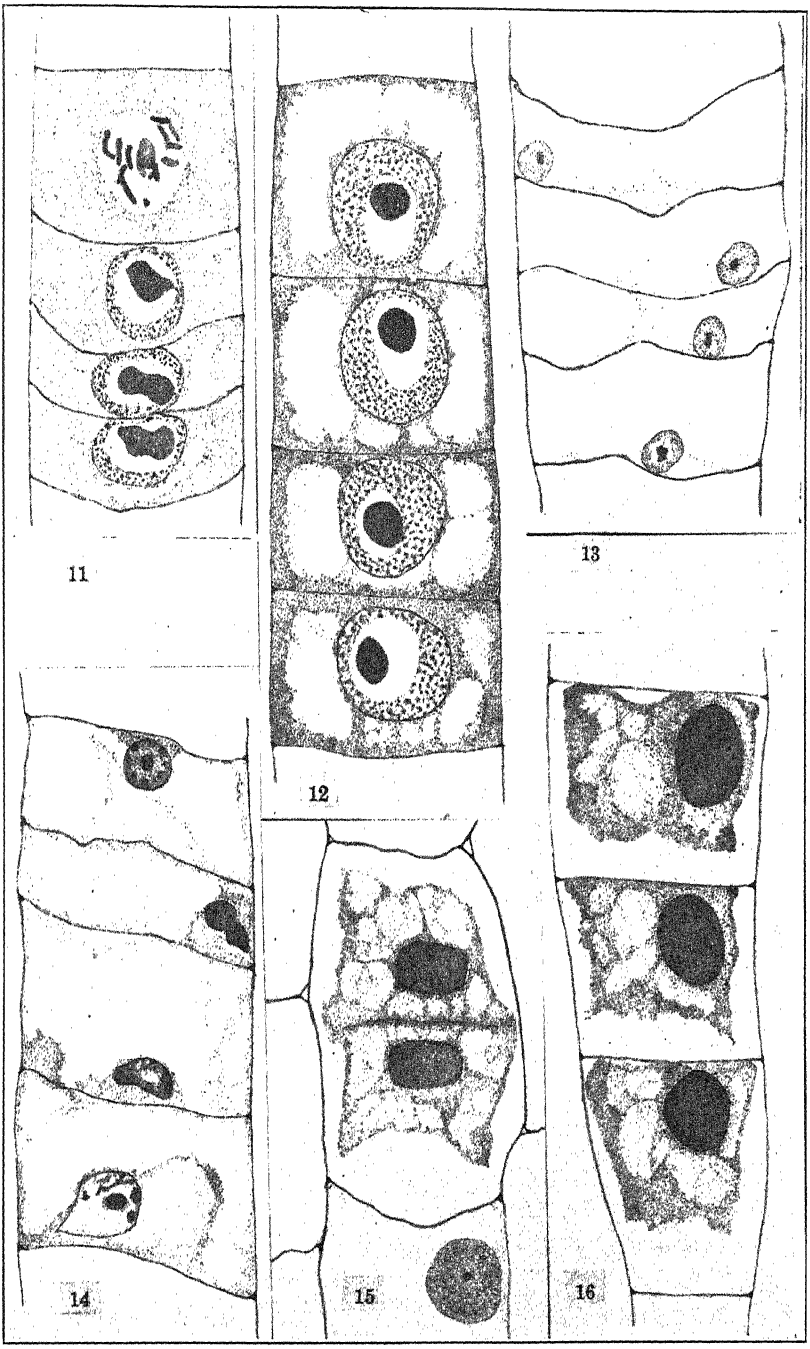
7



8

BAMFORD: CHANGES IN ROOT TIPS


9
10



BAMFORD: CHANGES IN ROOT TIPS

Growth and variability of wheat seedlings in magnesium sulphate solutions

JOSEPH CARMIN

(WITH THREE TEXT FIGURES)

The method used in this work was essentially the one described by Trelease and Trelease (1925). The wheat grains (pure line of spring wheat, Marquis, Saskatchewan, no. 70, selection no. 313, grown during the summer of 1922 and supplied by the University of Saskatchewan through the kindness of Professor Manley Champlin) were soaked for three hours in distilled water. Selected seeds were then distributed uniformly, furrow-side down, in glass moisture chambers containing two layers of white blotting paper saturated with distilled water. The germinators were placed in a dark chamber in which the temperature was kept fairly constant. The blotting paper was moistened with distilled water once or twice during germination. The seeds were left there about 24 hours, or until the primary root had attained a length of about 5 mm. They were then transferred to the culture vessels.

Each culture vessel consisted of a glass tumbler with a capacity of about 275 cc. placed in a larger beaker (600 cc.). The mouth of the smaller vessel was covered with a piece of a paraffined bobbinet tied with a paraffined linen thread. The vessels were filled with the culture solution until the level of the solution in both of them was even with the top of the smaller vessel.

The culture solutions were made up of Powers-Weightman-Rosengarten's analytical chemicals. The label for magnesium sulphate ($MgSO_4 \cdot 7H_2O$) showed the following analysis in percentages: alkali sulphate, 0.050; arsenic (As), 0.0000; calcium (Ca) 0.00; heavy metals 0.0000; iron (Fe) 0.0005; chloride (Cl) 0.0007. Twenty-five germinating seeds which were nearly uniform in appearance were selected and put on the netting of each culture vessel. The cultures were kept under the same conditions as the germinators. The first two days they were covered with an inverted watch glass. With each experiment two control cultures were grown in a balanced solution which contained 0.002 M $MgSO_4$, 0.002 M KH_2PO_4, and 0.002 M $Ca(NO_3)_2$. In addition, a single culture was grown in distilled water obtained from a Barnstead still. Each experiment was terminated when the longest root in the balanced solution had attained a length of about 90 mm. The seedlings of each culture were placed in a killing solution containing 0.2 per cent chromic acid and 0.1 per cent acetic acid dissolved in distilled

water. This solution proved to have no contracting influence upon the roots and tops of the seedlings.

Concentrations ranging from 0.0005 M to 0.0150 M $MgSO_4$ were tried. None of them showed any precipitate. For each solution one hundred seedlings were grown, twenty-five in each of four culture vessels. Two of the experiments were carried on simultaneously and the other two individually. The first and second experiments were carried out at a temperature of 17°–20° C., and it took 117 hours before the longest root in the balanced solution attained the required length (of approximately 90 mm.). The third experiment was carried out at 13°–22° C. for 130 hours, and the fourth experiment at 11.5°–20° C. for 150 hours. The low temperatures occurred only for short periods of time. The results show just as close an agreement between the first, third, and fourth experiments, which were carried on separately, as between the first and second one, carried on simultaneously. This indicates that the differences in temperature and other environmental conditions were not large enough to influence significantly the validity of the results of the experiments.

Four measurements were recorded for each seedling: the length of the principal root, the lengths of the two longest lateral roots (one from each side), the length of the longest root, and the length of the top. The results of the measurements for each lot of twenty-five seedlings were averaged and recorded. The probable error (P.E.) was computed in two ways: by the usual formula, and also as percentage of the mean, which gives a better idea of the discrepancies in probable error between the different experiments. The four experiments were then compared using Rietz and Smith's (1910) method. All cases were discarded in which the probable error of the difference between the experiments calculated by this formula was higher than five times the probable error. The remaining data were then averaged and plotted. Top root ratios were also calculated. The variability coefficients (C) were calculated by the usual formula ($C = 100\ \sigma$ divided by M) and plotted. The probable error of the variability coefficient was calculated by the formula: $E_c = 0.6745\ \sigma$ divided by $\sqrt{2n}$, and also as percentage of the variability coefficient. In a few cases the variability curves for the different organs in the different solutions used were also plotted. The skewness of the variability curves was calculated by Pearson's formula: $S =$ Mean minus Mode divided by σ. Finally the correlations between the different organs of the plant as well as between the left and the right side of the plant were calculated for the various solutions used.

RESULTS

The only morphological modification observed was that the tips of the roots became greatly swollen in the higher concentrations of the salt. The

growth of the roots in distilled water was almost as good as that in the balanced solution, as can be seen from tables 1–4 and figure 1, while the

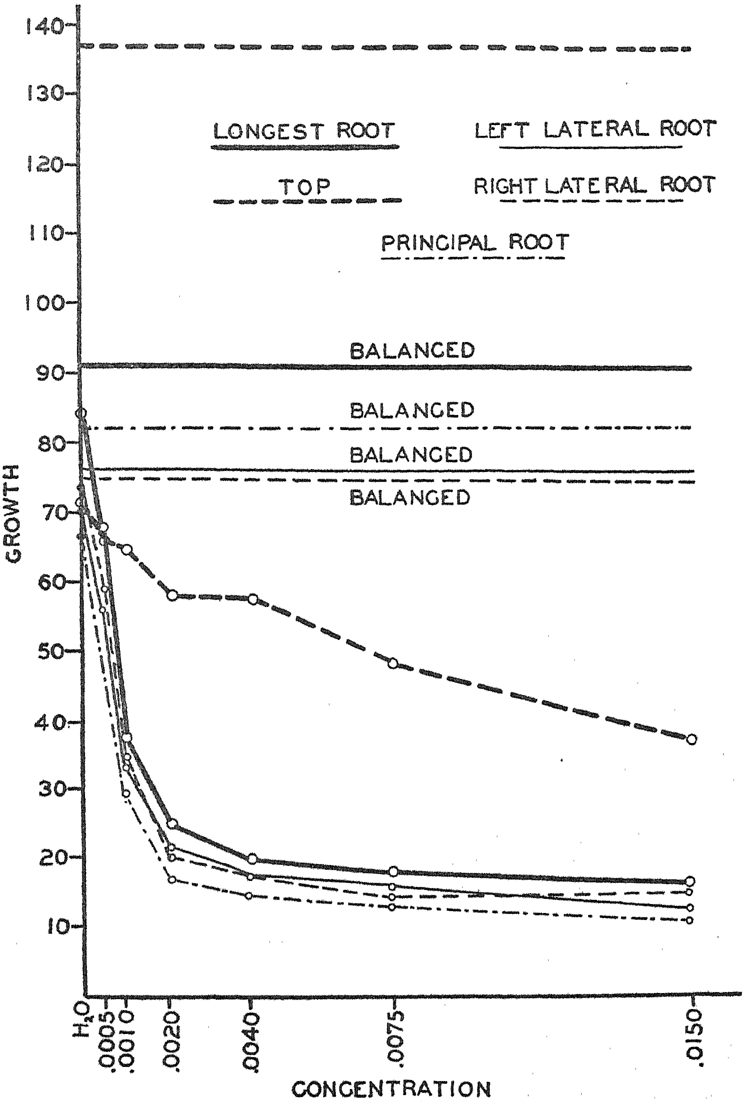


Fig. 1. Length of roots and tops (in mm.) of wheat seedlings grown in magnesium sulphate solutions.

tops attained in distilled water a length equaling approximately 50 per cent of their growth in the balanced solution. This indicates that distilled water lacks one of the elements necessary for normal top growth in young

TABLE 1

Length of principal roots (in mm.) of wheat seedlings grown in magnesium sulphate solutions

CONCENTRATION	FIRST EXPERIMENT			SECOND EXPERIMENT			THIRD EXPERIMENT			FOURTH EXPERIMENT			AVERAGE		
	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M
Dist. Water	—	—	—	—	—	—	61.1	4.1	6.7	72.2	2.1	2.8	66.6	2.5	3.7
0.0005M	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.0010M	27.2	1.2	4.4	—	—	—	30.0	2.1	7.0	29.2	0.7	2.4	28.8	0.8	2.8
0.0020M	15.9	0.6	3.8	15.9	0.8	5.0	—	—	—	18.1	0.5	2.8	16.6	0.4	2.4
0.0040M	14.2	0.7	4.9	14.8	0.7	4.7	16.9	0.7	4.1	15.4	0.5	3.2	15.4	0.3	1.9
0.0075M	12.8	0.5	3.9	12.0	0.4	3.3	14.2	0.6	4.2	12.1	0.4	3.3	12.8	0.3	2.3
0.0150M	9.0	0.3	3.3	8.6	0.3	3.5	—	—	—	9.6	0.3	3.1	9.6	0.2	2.1
	Mean	Prob. Error	P.E. in % of M												
Balanced	86.0	1.6	1.9				84.7	4.1	4.8	83.9	0.9	1.1	81.6	1.1	1.3
	76.1	2.2	2.9				74.7	3.9	5.2	84.6	0.9	1.1			

TABLE 2

Length of left lateral roots (in mm.) of wheat seedlings grown in magnesium sulphate solutions

<table>
<tr><th rowspan="2">CONCENTRATION</th><th colspan="3">FIRST EXPERIMENT</th><th colspan="3">SECOND EXPERIMENT</th><th colspan="3">THIRD EXPERIMENT</th><th colspan="3">FOURTH EXPERIMENT</th><th colspan="3">AVERAGE</th></tr>
<tr><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th></tr>
<tr><td>Dist. Water</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>66.1</td><td>3.4</td><td>5.1</td><td>76.6</td><td>1.3</td><td>1.7</td><td>71.4</td><td>2.0</td><td>2.8</td></tr>
<tr><td>0.0005M</td><td>60.2</td><td>1.6</td><td>2.6</td><td>51.8</td><td>2.7</td><td>5.2</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>56.0</td><td>2.1</td><td>3.8</td></tr>
<tr><td>0.0010M</td><td>38.3</td><td>1.2</td><td>3.1</td><td>30.3</td><td>1.4</td><td>4.6</td><td>31.8</td><td>1.5</td><td>4.7</td><td>32.3</td><td>0.9</td><td>2.8</td><td>33.2</td><td>0.7</td><td>2.1</td></tr>
<tr><td>0.0020M</td><td>19.8</td><td>0.9</td><td>4.5</td><td>22.6</td><td>1.0</td><td>4.4</td><td>20.3</td><td>0.7</td><td>3.4</td><td>20.4</td><td>0.6</td><td>2.9</td><td>20.8</td><td>0.4</td><td>1.9</td></tr>
<tr><td>0.0040M</td><td>16.3</td><td>0.7</td><td>4.3</td><td>18.5</td><td>0.7</td><td>3.8</td><td>16.7</td><td>0.9</td><td>5.3</td><td>16.5</td><td>0.6</td><td>3.6</td><td>17.0</td><td>0.4</td><td>2.4</td></tr>
<tr><td>0.0075M</td><td>13.8</td><td>0.5</td><td>3.6</td><td>13.7</td><td>0.5</td><td>3.6</td><td>15.4</td><td>0.6</td><td>3.9</td><td>15.8</td><td>0.6</td><td>3.8</td><td>14.7</td><td>0.3</td><td>2.0</td></tr>
<tr><td>0.0150M</td><td>10.8</td><td>0.5</td><td>4.6</td><td>11.2</td><td>0.5</td><td>4.5</td><td>—</td><td>—</td><td>—</td><td>11.8</td><td>0.5</td><td>4.2</td><td>11.3</td><td>0.3</td><td>2.6</td></tr>
<tr><td rowspan="2">Balanced</td><td colspan="2">Mean</td><td colspan="2">Prob. Error</td><td colspan="2">P.E. in % of M</td><td rowspan="2">69.4
77.4</td><td rowspan="2">2.9
2.6</td><td rowspan="2">4.5
3.5</td><td rowspan="2">80.1
81.1</td><td rowspan="2">0.9
0.8</td><td rowspan="2">1.1
1.0</td><td rowspan="2">75.8</td><td rowspan="2">0.9</td><td rowspan="2">1.2</td></tr>
<tr><td colspan="2">71.5
75.3</td><td colspan="2">2.9
1.1</td><td colspan="2">4.1
4.3</td></tr>
</table>

TABLE 3

Length of right lateral roots (in mm.) of wheat seedlings grown in magnesium sulphate solutions

<table>
<tr><th rowspan="2">CONCENTRATION</th><th colspan="3">FIRST EXPERIMENT</th><th colspan="3">SECOND EXPERIMENT</th><th colspan="3">THIRD EXPERIMENT</th><th colspan="3">FOURTH EXPERIMENT</th><th colspan="3">AVERAGE</th></tr>
<tr><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th><th>Mean</th><th>Prob. Error</th><th>P.E. in % of M</th></tr>
<tr><td>Dist. Water</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>65.1</td><td>2.6</td><td>4.0</td><td>80.5</td><td>1.4</td><td>1.7</td><td>72.8</td><td>1.9</td><td>2.6</td></tr>
<tr><td>0.0005M</td><td>63.0</td><td>1.6</td><td>2.5</td><td>54.7</td><td>2.8</td><td>5.1</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>58.9</td><td>1.7</td><td>2.9</td></tr>
<tr><td>0.0010M</td><td>40.3</td><td>1.3</td><td>3.2</td><td>28.2</td><td>0.3</td><td>3.2</td><td>35.0</td><td>1.5</td><td>4.3</td><td>32.6</td><td>1.2</td><td>3.7</td><td>34.0</td><td>0.7</td><td>2.1</td></tr>
<tr><td>0.0020M</td><td>20.5</td><td>0.7</td><td>3.4</td><td>20.2</td><td>0.9</td><td>3.0</td><td>17.5</td><td>1.0</td><td>5.7</td><td>20.5</td><td>0.7</td><td>3.4</td><td>19.7</td><td>0.4</td><td>2.0</td></tr>
<tr><td>0.0040M</td><td>15.3</td><td>0.6</td><td>3.9</td><td>16.2</td><td>0.5</td><td>3.1</td><td>17.8</td><td>0.7</td><td>4.5</td><td>16.4</td><td>0.7</td><td>4.2</td><td>16.5</td><td>0.4</td><td>2.4</td></tr>
<tr><td>0.0075M</td><td>15.2</td><td>0.5</td><td>3.2</td><td>12.5</td><td>0.5</td><td>4.0</td><td>13.9</td><td>0.6</td><td>4.3</td><td>15.4</td><td>0.6</td><td>3.9</td><td>14.2</td><td>0.3</td><td>2.1</td></tr>
<tr><td>0.0150M</td><td>11.8</td><td>0.5</td><td>4.2</td><td>12.0</td><td>0.5</td><td>4.2</td><td>14.9</td><td>0.5</td><td>3.3</td><td>13.1</td><td>0.9</td><td>6.9</td><td>12.9</td><td>0.3</td><td>2.3</td></tr>
<tr><td rowspan="2">Balanced</td><td colspan="2">Mean</td><td colspan="2">Prob. Error</td><td colspan="2">P.E. in % of M</td><td rowspan="2">63.5
74.8</td><td rowspan="2">3.3
2.0</td><td rowspan="2">5.2
2.7</td><td rowspan="2">81.3
82.1</td><td rowspan="2">1.0
0.7</td><td rowspan="2">1.2
0.8</td><td rowspan="2">74.8</td><td rowspan="2">0.9</td><td rowspan="2">1.2</td></tr>
<tr><td colspan="2">75.5
71.8</td><td colspan="2">2.6
2.6</td><td colspan="2">3.4
3.6</td></tr>
</table>

TABLE 4

Length of longest roots (in mm.) of wheat seedlings grown in magnesium sulphate solutions

CONCENTRATION	FIRST EXPERIMENT			SECOND EXPERIMENT			THIRD EXPERIMENT			FOURTH EXPERIMENT			AVERAGE		
	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M
Dist. Water	—	—	—	—	—	—	82.8	1.7	2.1	84.6	1.0	1.2	83.7	1.0	1.2
0.0005M	68.2	1.3	1.9	67.3	1.9	2.8	—	—	—	—	—	—	67.7	1.1	1.6
0.0010M	—	—	—	33.5	1.3	3.9	42.1	1.4	3.3	36.1	0.9	2.5	37.2	0.8	2.2
0.0020M	23.5	0.6	2.5	25.0	0.9	3.6	28.0	0.8	2.8	23.2	0.7	3.0	24.9	0.4	1.6
0.0040M	19.2	0.5	2.6	20.3	0.6	2.9	21.1	0.7	3.3	19.7	0.5	2.5	20.0	0.3	1.5
0.0075M	16.9	0.4	2.4	14.9	0.5	3.3	17.8	0.5	2.8	17.7	0.6	3.4	16.8	0.3	1.8
0.0150M	13.1	0.5	3.8	13.7	0.5	3.6	—	—	—	14.8	0.8	5.4	13.9	0.3	2.2
	Mean			Prob. Error	P.E. in % of M										
Balanced	90.8			0.9	1.0		95.3	1.6	1.7	86.1	0.8	0.9			
	—			—	—		93.0	1.2	1.3	—	—	—	91.3	0.6	0.6

TABLE 5

Length of tops (in mm.) of wheat seedlings grown in magnesium sulphate solutions

CONCENTRATION	FIRST EXPERIMENT			SECOND EXPERIMENT			THIRD EXPERIMENT			FOURTH EXPERIMENT			AVERAGE		
	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M	Mean	Prob. Error	P.E. in % of M
Dist. Water	NOT MEASURED						72.7	1.9	2.6	70.2	1.0	1.8	71.4	1.1	1.5
0.0005M							67.5	1.2	1.8	66.9	1.0	1.5	67.2	0.8	1.2
0.0010M							64.1	1.4	2.2	64.4	1.2	1.8	64.2	0.9	1.4
0.0020M							55.6	1.9	3.4	58.5	1.1	1.9	57.0	1.1	1.9
0.0040M							57.9	1.6	2.7	56.5	1.0	1.8	57.2	1.0	2.7
0.0075M							46.9	1.7	3.6	49.4	1.1	2.2	48.2	1.0	2.1
0.0150M							39.9	1.6	4.0	33.0	0.8	2.4	36.5	1.0	2.7
Balanced							146.5	1.2	0.8	125.0	0.8	0.7	136.5	3.1	2.3
							146.2	2.0	1.4	128.5	0.6	0.4			

seedlings. In figure 1 it can be seen that the curves of root growth in various concentrations of magnesium sulphate solutions are smooth, with no indication of irregularities; they fall very rapidly at first, then more and more slowly, so that finally they become practically straight lines nearly parallel to the base line, which would correspond to the so-called death point. This point agrees very well with Harter's (1905) results. The means for the length of the left and right lateral roots are approximately the same in all solutions tried, including the distilled water and balanced solutions. The principal root was about five mm. longer than the other roots in the balanced solution. This might be expected since, at the start of the experiment, it was about five mm. long, before the appearance of the lateral roots. It is interesting that, in spite of this fact, the principal root is shorter than the laterals in all magnesium sulphate solutions and distilled water as well, which means that these solutions are in some way or other more toxic to the principal roots than to the lateral ones.

The curve for the rate of top growth does not run so smoothly as those for root growth. This might possibly be explained by the fact that the averages for the tops are only for 50 individuals, while for the root values 100 individuals were measured in each case. The curve for top growth falls much more slowly than those for root growth. It seems that the roots may have had some ability to hinder the toxic magnesium sulphate from getting at the tops, either by retaining it, or in some other way. In the lowest concentrations the tops are somewhat shorter than the roots, but with increase of concentration the roots are shorter than the tops. Magnesium sulphate must hinder the growth of roots much more than that of the tops. This can also be seen from the gradual rise in the top-root ratio, which is 0.8 for distilled water; 1.0 for 0.0005 M solution; 1.7 for 0.0010 M solution; 2.3 for 0.0020 M solution; 2.9 for 0.0040 M solution; 2.9 for 0.0075 M solution; 2.6 for 0.150 M solution. For the balanced solution it is 1.5.

For all magnesium sulphate solutions there was a lack of correlation between principal root and top, between longest root and top, and between the right lateral and the left lateral root. The balanced solution showed a slight correlation between longest root and top as well as between the principal root and top, it was 0.3431 ± 0.0687 in the first case and 0.3389 ± 0.0597 in the second case. Thus under normal conditions there exists in young seedlings some correlation between growth rate of roots and tops. This correlation is broken down in some way in distilled water and in magnesium sulphate solutions.

Tables 6 and 7 contain the variability coefficients (C) for roots and tops. The probable error in percentages of C is a fairly constant number, around 10, which shows that the seeds for this experiment were selected very care-

TABLE 6

Coefficient of variability (C) for longest roots

CONCENTRATION	FIRST EXPERIMENT			SECOND EXPERIMENT			THIRD EXPERIMENT			FOURTH EXPERIMENT			AVERAGE		
	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C
Dist. Water	—	—	—	—	—	—	15.6	1.5	9.6	9.0	1.1	12.2	12.8	0.8	6.2
0.0005M	14.1	1.4	10.0	21.1	2.2	10.0	—	—	—	—	—	—	17.9	1.3	7.3
0.0010M	—	—	—	28.4	3.1	10.9	24.0	2.5	10.4	19.2	2.0	10.4	28.3	1.8	6.4
0.0020M	20.9	2.1	10.0	26.4	2.9	10.9	21.1	2.2	10.4	22.5	2.4	10.7	25.2	1.4	5.5
0.0040M	20.3	2.1	10.3	20.2	2.1	10.4	24.2	2.5	10.3	21.0	2.1	10.0	22.6	0.8	3.6
0.0075M	18.5	1.9	10.3	22.8	2.4	10.5	23.0	2.4	10.4	24.8	2.6	10.4	28.6	1.6	5.6
0.0150M	26.0	2.9	11.2	24.8	2.7	10.9	—	—	—	39.7	5.0	12.6	31.3	1.9	6.1
	Coef. of Var.			Prob. Error		P.E. in % of C									
Balanced	7.5 —			0.7 —		9.3 —	12.2 10.0	1.2 1.0	9.8 10.0	7.0 —	0.7 —	10.0 —	10.2	0.5	4.9

TABLE 7

Coefficient of variability (C) for tops.

CONCENTRATION	FIRST EXPERIMENT			SECOND EXPERIMENT			THIRD EXPERIMENT			FOURTH EXPERIMENT			AVERAGE		
	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C	Coef. of Var.	Prob. Error	P.E. in % of C
Dist. Water	NOT MEASURED						19.7	1.9	9.6	10.7	1.0	9.3	16.1	1.1	6.9
0.0005M							13.3	1.3	9.8	10.6	1.0	9.4	12.2	0.8	6.5
0.0010M							15.9	1.6	10.0	14.3	1.4	9.8	15.1	1.1	7.3
0.0020M							24.8	2.7	10.9	14.5	1.4	9.6	20.5	1.5	7.3
0.0040M							21.9	2.2	10.0	13.6	1.4	10.3	18.5	1.3	7.0
0.0075M							26.4	1.2	4.5	17.0	1.7	10.0	22.6	1.7	7.5
0.0150M							29.8	3.4	11.4	17.6	1.8	10.2	28.3	2.2	7.8
Balanced							6.1 10.1	0.6 1.0	9.8 9.9	4.7 3.3	0.4 0.3	8.5 9.1	12.2	0.8	6.5

fully. The averages for variability coefficients of the longest roots and tops are plotted in figure 2. The curve for longest roots runs parallel to the one for tops. This graph shows that the solution in which the seeds are grown has a very pronounced influence upon the variability of seedling growth. The variability coefficient is the lowest in distilled water and in the balanced solution. These media might be regarded as furnishing natural con-

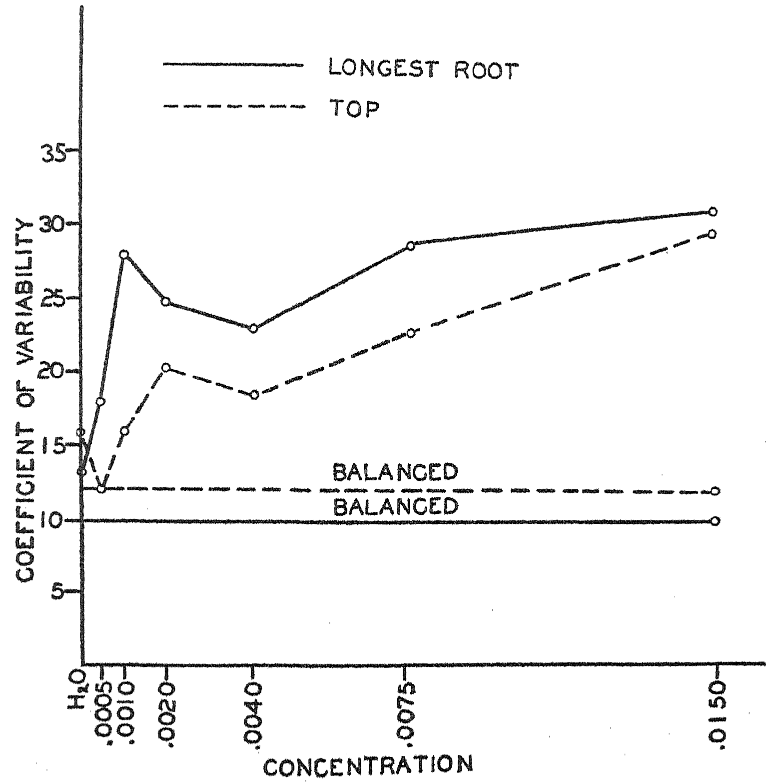


Fig. 2. Coefficients of variability for longest roots and tops.

ditions for the wheat seedlings (water, only in earlier stages of seedling growth). The variability is larger in the magnesium sulphate solutions, it rises in the lowest concentrations for tops as well as roots, falls for both of them at the concentration of 0.0020 M and 0.0040 M, and then rises again for roots as well as tops in the highest concentrations tried. This confirms the previous work of Goldschmidt (1928), Jennings (1908), Klebs (1907), Bumpus (1898), Duncker (1904), and others, indicating that the variability of organisms increases in changed conditions. The variability becomes greater in our case with the increase in the concentration of mag-

nesium sulphate. Variability coefficients are larger for longest roots than for tops.

Figure 3 shows the influence of the different solutions upon the variability curves of the longest root. The skewness figured by Pearson's formula was very slight. For the longest roots it was 0.1 mm. in distilled water, 0.4 mm. in 0.0005 M $MgSO_4$, 0.4 mm. in 0.0010 M $MgSO_4$, 0.4 mm. in 0.0020 M $MgSO_4$, 0.6 mm. in 0.0040 M $MgSO_4$, 0.1 mm. in 0.0075 M $MgSO_4$, 0.3 mm. in 0.0150 M $MgSO_4$, and 0.1 mm. in the balanced solution. For tops it was 0.1 mm. in distilled water, 0.6 mm. in 0.0005 M $MgSO_4$, 0.1 mm. in 0.0010 M $MgSO_4$, 0.8 mm. in 0.0020 M $MgSO_4$, 0.5 mm. in

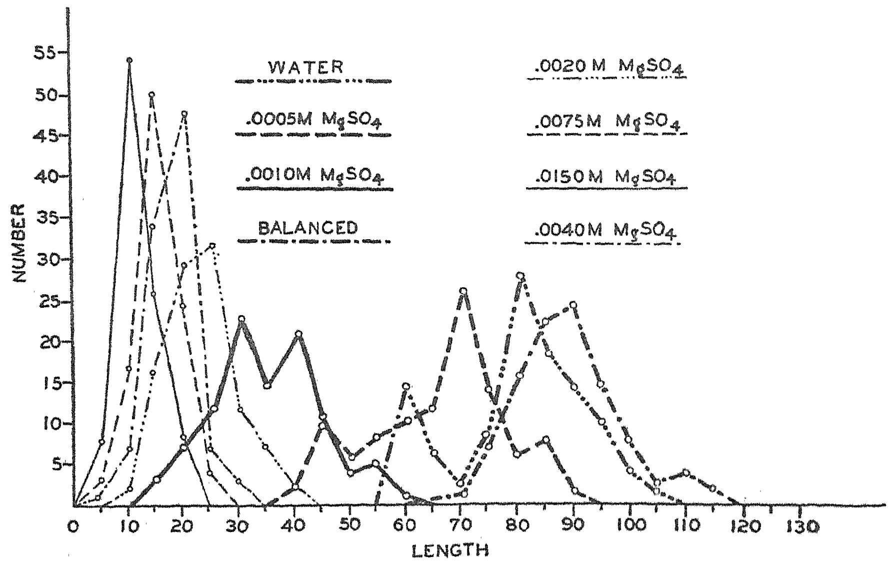


Fig. 3. Variability curves for longest roots. Ordinates represent number of individuals; abscissas, length in mm.

0.0040 M $MgSO_4$, 0.6 mm. in 0.0075 M $MgSO_4$, 0.4 mm. in 0.0150 M $MgSO_4$, and 0.5 mm. in the balanced solution. It can clearly be seen that the variability curves move to the left with the increase of the concentration. Simultaneously there occurs a gradual decrease of the dispersion range and a rise of the mode. Distilled water and the balanced solution show approximately the same variability curves as the lowest concentrations of magnesium sulphate, they are moved only slightly to the right. The same thing is brought out by the measurements of the other organs (principal root, left lateral root, right lateral root, and top). The jointed tops of the modes of the variability curves form a smoothly running curve, similar for all measured organs of the plant.

SUMMARY

A study was made of growth and variability of very young wheat seedlings in a wide range of concentrations of magnesium sulphate solutions. One hundred seedlings growing in the dark were tested with each solution, and the elongation of principal roots, left lateral roots, right lateral roots and tops was studied. The main results follow:

1. Growth of roots as well as of tops, when plotted against concentration of magnesium sulphate, gave smooth curves that fall at first rapidly in the lower concentrations tested, then with decreasing rapidity; in highest concentrations tested the curves become parallel to the base.

2. Magnesium sulphate was found to be more toxic to roots than to tops, and more toxic to principal roots than to the lateral roots.

3. Roots grew in distilled water almost as rapidly as in the balanced solution, while tops grew in distilled water only half as rapidly as in the balanced solution.

4. There was no correlation whatever between measured organs in any of the tested magnesium sulphate solutions nor in distilled water. In the balanced solution there existed a slight correlation between the longest root and the top as well as between the principal root and the top.

5. Variability coefficients were lowest in the balanced solution and distilled water; their values rose with an increase in concentration of the magnesium sulphate solution, with the exception of 0.0020 M and 0.0040 M $MgSO_4$. They were larger for longest roots than for tops.

6. The skewness of the variability curves was very slight in all magnesium sulphate solutions tested as well as in the balanced solution and distilled water.

7. With increase in the concentration of magnesium sulphate solutions there occurred a movement of the variability curves to the left, a decrease in their dispersion range, and a rise of the mode.

This opportunity is gladly taken to express indebtedness to Dr. Sam F. Trelease for suggesting the problem of the present work as well as for directing and criticizing it; to Mrs. Helen M. Trelease for valuable suggestions on the technique; and to Dr. Scheinkin for valuable help in calculating and computing the results as well as for criticizing the entire work.

INDEPENDENT BIOLOGICAL LABORATORIES
TEL-AVIV, PALESTINE

Literature cited

Bumpus, H. C. 1898. The variations and mutations of Littorina. Zool. Bull. **1**: 247–259.

Duncker, G. 1904. Symmetrie und Asymmetrie bei bilateralen Thieren. Arch. f. Entwickelungsmechanik **17**: 533–682.

Goldschmidt, R. 1928. Einführung in die Vererbungswissenschaft. 568 p. Berlin: Julius Springer.

Jennings, H. S. 1908. Heredity, variation, and evolution in protozoa. Jour. Exp. Zool. **5**: 577–632.

Harter, L. L. 1905. The variability of wheat varieties in resistance to toxic salts. U. S. Dept. of Agric. Bur. Pl. Ind. Bull. 79: 1–48.

Klebs, G. 1907. Studien über Variation. Arch. f. Entwicklungsmechanik **24**: 29–113.

Rietz, H. L., and L. H. Smith. 1910. On the measurement of correlation with special reference to some characters of Indian corn. Univ. Illinois Agric. Exp. Sta. Bull. **148**: 291–316.

Trelease, S. F., and H. M. Trelease. 1925. Growth of wheat roots in salt solutions containing essential ions. Bot. Gaz. **80**: 74–83.

INDEX TO AMERICAN BOTANICAL LITERATURE
1930–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Adolph, E. F. The regulation of size as illustrated in unicellular organisms, i–viii, 1–233. *f. 1–66.* Springfield, Ill., 1931.

Alexander, E. J. *Clintonia borealis.* Addisonia **15**: 51–52. *pl. 506.* "D 1930" 12 Mr 1931.

Alexander, E. J. *Gilia rubra.* Addisonia **15**: 63–64. *pl. 512.* "D 1930" 12 Mr 1931.

Alexander, E. J. *Pueraria Thunbergiana.* Addisonia **15**: 57–58. *pl. 509.* "D 1930" 12 Mr 1931.

Allen, T. C. Bacteria producing rot of apple in association with the apple magot, *Rhagoletis pomonella.* Phytopathology **21**: 338. Mr 1931.

Anderson, E. Internal factors affecting discontinuity between species. Am. Nat. **65**: 144–148. *f. 1.* Mr 1931.

Anderson, E., & DeWinton, D. The genetic analysis of an unusual relationship between self-sterility and self-fertility in *Nicotiana.* Ann. Missouri Bot. Gard. **18**: 97–116. *pl. 4 +f. 1–7.* F 1931.

Anderson, W. B. A *Sisyrinchium* new to Canada. Gard. Chron. **89**: 219. 21 Mr 1931.

Arnold, C. A. Cordaitean wood from the Pennsylvanian of Michigan and Ohio. Bot. Gaz. **91**: 77–87. *f. 1–10.* 18 Mr 1931.

Cordaites michiganensis and *Dadoxylon Romingerianum* described as new.

Backeberg, C. Das Kakteenvorkommen von Trinidad bis Caribisch-Kolumbien. Monats. Deutsch. Kakteen-Gesell. **3**: 64–67. Mr 1931.

Bailey, F. D., & Zeller, S. M. The occurrence of *Schizophyllum commune* on green apples. Mycologia **23**: 154–155. *f. 1.* 2 Mr 1931.

Baird, R. O. A recent Cactus expedition. Gard. Chron. Am. **35**: 51–52. *illust.* F 1931.

Barnhart, J. H. *Pinguicula Jackii.* Addisonia **15**: 61–62. *pl. 511.* "D 1930" 12 Mr 1931.

Bartholomew, E. Additions to "the fungous flora of Kansas." Trans. Kansas Acad. Sci. **33**: 82–83. 1930.

Bartholomew, R. P. Changes in the availibity of phosphorus in irrigated rice soils. Soil Sci. **31**: 209–218. Mr 1931.

Baxter, D. V. The fungi and the decay of the American chestnut: Part I. Papers Michigan Acad. Sci. **14**: 259–290. *pl. 32–49.+map 3.* 1931.

Baxter, D. V. A preliminary study of *Coleosporium Solidaginis* (Schw.) Thüm. in forest plantations in the region of the Lake states. Papers Michigan Acad. Sci. **14**: 245–258. *pl. 26–31.* 1931.

Baxter, D. V., & Strong, F. C. Chestnut blight in Michigan. Michigan Agr. Exp. Sta. Bull. 135: 1–18. *pl. 1–8.* F 1931.

Baxter, E. M. The genus *Lophocereus*. Jour. Cactus & Succ. Soc. Am. **2**: 431–432. *illust.* Mr 1931.

Berger, A. *Kleinia* L. Section I. Notonia. Desert **2**: 139. *illust.* Mr 1931; II. Eukleinia 154. *illust.* Ap. 1931.

Bertram, P. *Opuntia Canterai* Arechavaleta. Succulenta **13**: 21–24. *illust.* F 1931.

Birdsall, L. B. Parents of the tulips. Gard. Chron. Am. **35**: 91. Mr 1931.

Bödeker, F. Etwas über Nieder-Californien und seine Mamillarien und Echinocacteen. Monats. Deutsch. Kakteen.-Gesell. **3**: 36–37. F 1931.

Bödeker, F. Was ist *Mamillaria Brandegeei* Eng. und was ist *Mamillaria Gabbii* Eng.? Monats. Deutsch. Kakteen.-Gesell. **3**: 50–52. *illust.* Mr 1931.

Boynton, K. R. *Cheiranthus Allionii.* Addisonia **15**: 55–56. *pl. 508.* "D 1930" 12 Mr 1931.

Boynton, K. R. *Erysimum linifolium.* Addisonia **15**: 53–54. *pl. 507.* "D 1930" 12 Mr 1931.

Boynton, K. R. *Viola* "apricot." Addisonia **15**: 49–50. *pl. 505.* "D 1930" 12 Mr 1931.

Brand, A. Borraginaceae-Borraginoideae-Cryptantheae. Pflanzenreich 4^{252}: 1–236. *f. 1–22.* 1931.

Brittingham, W. H. *Oenothera Lamarckiana* mut. *acutifolia*, a new mutant type produced by a gene outside the first linkage group. Am. Nat. **65**: 121–133. *f. 1, 2.* Mr 1931.

Briton-Jones, H. R., & Cheesman, E. E. Witch broom control. A new aspect of witch broom control in Trinidad. Jour. Imp. Coll. Trop. Agr. **8**: 79–89. *pl. 1, 2.* Ap 1931.

Broadway, M. E. Baby Cacti in the West Indies. Jour. Cactus & Succ. Soc. Am. **2**: 440. Mr 1931.

Broadway, W. E. Trinidad orchids. Orchid Rev. **39**: 35. F 1931; 109. Ap 1931.

Brooks, M. M. The penetration of 1-naphthol-2-sulphonate indophenol, 0-chloro phenol indophenol and 0-cresol indo-

phenol into *Valonia*. Proc. Nat. Acad. Sci. **17**: 1–3. 15 Ja 1931.

Brown, N. E. Some new species of *Conophytum*. Jour. Cactus & Succ. Soc. Am. **2**: 425–429. *f. 1–17*. Mr 1931.

Bush, B. F. Some *Lacinaria* species. Am. Midl. Nat. **12**: 312–318. Mr 1931.

Cabrera, A. L. Notas sobre compuestas de la Republica Argentina. Physis **10**: 279–289. *f. 1, 2*. 30 Ja 1931.

Cain, S. A. Ecological studies of the vegetation of the Great Smoky Mountains of North Carolina and Tennessee. I. Soil reaction and plant distribution. Bot. Gaz. **91**: 22–41. *f. 1–6*. 18 Mr 1931.

Cejp, K. Notes on Iowa species of the genus *Irpex*. Mycologia **23**: 130–133. *f. 1*. 2 Mr 1931.

Cheney, L. S. Wisconsin fossil mosses. Bryologist **33**: 66–68. "S 1930" 13 Mr 1931.

Chrysler, M. A. A fossil cycad in New Jersey. Science II. **73**: 209–210. 20 F 1931.

Churchill, B. R. Investigations with oat varieties and diseases in the Upper Peninsula. Michigan Agr. Exp. Sta. Spec. Bull. 213: 1–15. *f. 1–3*. F 1931.

Ciferri, R. Contributions to the classification of Torulopsidaceae. I. An American variety of *Torulopsis minuta*. Mycologia **23**: 140–146. *f. 1*. 2 Mr 1931.

Ciferri, R. A new variety of *Eutorulopsis dubia* Ciferri & Redaelli. Zentralb. Bakt. 2 Abt. **83**: 33–37. *f. 1–3*. 20 F 1931.

Clayton, E. E. Cucumber disease investigations in Long Island. Geneva N. Y. Agr. Exp. Sta. Bull. 590: 1–20. *f. 1–5*. Ja 1931.

Clements, H. F. The upward movement of inorganic solutes in plants. State Coll. Washington Res. Stud. **2**: 91–106. *f. 1–5*. "S 1930" 15 Ja 1931.

Colley, M. W. Culture experiments with *Pseudomonas tumefaciens*. Am. Jour. Bot. **18**: 211–214. *f. 1*. 23 Mr 1931.

Colley, M. W. Notes on the technique of measuring the growth of bacteria with a nephelometer. Am. Jour. Bot. **18**: 205–210. 23 Mr 1931.

Collins, J. L., Hollingshead, L., & Avery, P. The *Crepis setosa* chromosomes present in *Crepis artificialis*; a correction of Tischler's statement concerning autosyndesis among *setosa* chromosomes. Am. Nat. **65**: 191–192. Mr 1931.

Craig, W. N. Lily notes from America. Gard. Chron. **89**: 86–87. *f. 41, 42*. 31 Ja 1931.

Critchell-Bullock, J. C. An expedition to sub-Arctic Canada, 1924–1925. Canadian Field Nat. **45:** 31–35. F 1931.
Includes a list of plants collected between Sifton Lake and Aberdeen.

Cross, G. L. Meristem in *Osmunda cinnamomea*. Bot. Gaz. **91:** 65–76. *f. 1–15*. 18 Mr 1931.

Dale, E. E. Inheritance of dwarf in *Capsicum*. Papers Michigan Acad. Sci. **13:** 1–4. Mr 1931.

Dale, E. E. Maternal inheritance in a chlorophyll variegation in *Capsicum*. Papers Michigan Acad. Sci. **13:** 5–8. *pl. 1*. Mr 1931.

Darlington, H. T. Vegetation of the Porcupine Mountains, northern Michigan. Papers Michigan Acad. Sci. **13:** 9–65. *pl. 2–28*. Mr 1931.

Davis, L. D. Some carbohydrate and nitrogen constituents of alternate-bearing sugar prunes associated with fruit bud formation. Hilgardia **5:** 119–154. *f. 1–12*. Ja 1931.

Dearness, J. *Volvaria speciosa*. Mycologia **23:** 152–153. 2 Mr 1931.

Detwiler, S. B. The white pine blister rust situation. Jour. Forest. **29:** 181–185. F 1931.

Deuber, C. G. Chemical treatments to shorten the rest period of tree seeds. Science II. **73:** 320–321. 20 Mr 1931.

Dillman, A. C. The water requirement of certain crop plants and weeds in the northern Great Plains. Jour. Agr. Res. **42:** 187–238. *f. 1–13*. 15 F 1931.

Dillon Weston, W. A. R. Virulency of *Tilletia caries* on wheat varieties. Nature **127:** 483–484. 28 Mr 1931.

Dolk, H. E. The movements of the leaves of the compass-plant, *Lactuca scariola*. Am. Jour. Bot. **18:** 195–204. *f. 1–8*. 23 Mr 1931.

Dowding, E. S. Floral morphology of *Arceuthobium americanum*. Bot. Gaz. **91:** 42–54. *f. 1–11*. 18 Mr 1931.

Eames, A. J. The vascular anatomy of the flower with refutation of the theory of carpel polymorphism. Am. Jour. Bot. **18:** 147–188. *f. 1–29*. 23 Mr 1931.

Eaton, R. J. *Cuscuta Polygonorum* in New England. Rhodora **33:** 80. 7 Mr 1931.

Edgecombe, A. E. Immunological relationship of wheats resistant and susceptible to *Puccinia rubigo-vera Triticina*. Bot. Gaz. **91:** 1–21. 18 Mr 1931.

Edwards, W. N. W. Jongman's Fossilium catalogus II. Plantae. Dicotyledones (Ligna). Part 17: 1–96. 1931.

Emmons, C. W. Observations on *Archorion gypsum*. Mycologia **23:** 87–95. *pl. 9, 10+f. 1*. 2 Mr 1931.

Erlanson, E. W. A group of tetraploid roses in central Oregon. Bot. Gaz. **91**: 55–64. *f. 1–3.* 18 Mr 1931.

Erwin, A. T. Nativity of the cucurbits. Bot. Gaz. **91**: 105–108. *f. 1–3.* 18 Mr 1931.

Farwell, O. A. Concerning some species of *Cornus* of Philip Miller. Rhodora **33**: 69–72. 7 Mr 1931.

Featherly, H. I. A new species of grama grass. Bot. Gaz. **91**: 103–105. *f. 1–4.* 18 Mr 1931.

Ferguson, M. A botanical problem. Science II. **73**: 193–197. 20 F 1931.

Fernald, M. L. Some rare plants of Scotland. Jour. Bot. **69**: 8–10. Ja 1931.

Frick, K. O. Three days afield in southern Arizona. Jour. Cactus & Succ. Soc. Am. **2**: 438–440. *illust.* Mr 1931.

Fritz, E., & Bonar, L. The brown heart-rot of California redwood. I. Notes on the development of the causal fungus. Jour. Forest. **29**: 368–376; II. The etiology of the causal fungus. 377–380. *f. 1–7.* Mr 1931.

Part I by E. Fritz, part 2 by L. Bonar.

Frost, F. H. Specialization in secondary xylem of Dicotyledons. III. Specialization of lateral wall of vessel segment. Bot. Gaz. **91**: 88–96. *f. 1–8.* 18 Mr 1931.

Fuller, H. J. Stimulatory effects of radiation from a quartz mercury vapor arc upon higher plants. Ann. Missouri Bot. Gard. **18**: 17–40. *pl. 3.* F 1931.

Fuller, J. E., & Rettger, L. F. The influence of combined nitrogen on growth and nitrogen fixation by *Azotobacter*. Soil Sci. **31**: 219–234. Mr 1931.

Gates, F. C. Botanical notes, 1928–1929. Trans. Kansas Acad. Sci. **33**: 26–28. 1930.

Gates, F. C., & Ehlers, J. H. Additions to an annotated list of the higher plants of the region of Douglas Lake, Michigan. II. Papers Michigan Acad. Sci. **13**: 67–88. Mr 1931.

Gates, R. R. The cytological basis of mutations. Am. Nat. **65**: 97–120. Mr 1931.

Gielsdorf, K. *Echinocereus polyacanthus* Engelm. Monats. Deutsch. Kakteen-Gesell. **3**: 64. *illust.* Mr 1931.

Gielsdorf, K. *Phyllocactus anguliger* Lem. Monats. Deutsch. Kakteen-Gesell. **3**: 56. *illust.* Mr 1931.

Gilmore, M. R. Dispersal by Indians a factor in the extension of discontinuous distribution of certain species of native plants. Papers Michigan Acad. Sci. **13**: 89–94. Mr 1931.

Godbout, F. L. La travelure du pommier *Venturia inaequalis* (Cke.) Wint. Nat. Canadien **58**: 25–31. *f. 1–4.* F 1931.

Godfrey, G. H. The host plants of the "burrowing" nematode *Tylenchus similis*. Phytopathology **21**: 315–322. *f. 1–4*. Mr 1931.

Graham, S. A. The effect of defoliation on tamarack. Jour. Forest. **29**: 199–206. F 1931.

Graves, E. W. *Botrychium dissectum* from Minnesota. Am. Fern Jour. **21**: 21–24. Ja–Mr 1931.

Griffiths, D., Wright, R. C., & Lumsden, D. V. Daffodil storage and forcing in 1930–31. Flor. Exch. **76**: 9, 43. *illust.* 28 F 1931.

Guard, A. T. Development of floral organs of the soy bean. Bot. Gaz. **91**: 97–102. *f. 1–16*. 18 Mr 1931.

Gustafson, F. G., & Laing, H. E. Growth studies on fruits. The effect of the removal of alternate flower clusters on the development of fruits in the tomato. Papers Michigan Acad. Sci. **13**: 95–99. Mr 1931.

Haas, A. R. C., & Klotz, L. J. Some anatomical and physiological changes in *Citrus* produced by boron deficiency. Hilgardia **5**: 175–194. *pl. 1–4+f. 1–4*. Ja 1931.

Halperin, M. A taxonomic study of *Poa bulbosa* L. Univ. California Publ. Bot. **16**: 171–183. 24 Mr 1931.

Hansen, A. A. Indiana plants injurious to livestock. Purdue Univ. Agr. Exp. Sta. Circ. 175: 1–38. *f. 1–28*. Jl 1930.

Hastings, W. H. William Harmon Wright. 1885–1929. Phytopathology **21**: 243–246. *portrait.* Mr 1931.

Hedrick, J. Lichens from the State of Oklahoma. Papers Michigan Acad. Sci. **13**: 101–110. Mr 1931.

Heilborn, O. On some species of *Tropaeolum* from Ecuador. Ark. Bot. **23A**[9]: 1–10. *f. 1–4*. 1931.

Heilborn, O. Section fruticosae Eich. of the genus *Cleome* L. Ark. Bot. **23A**[10]: 1–19. *f. 1–6*. 1931.
Nine new species are described.

Hill, A. G. Goldenrods. Bull. Gard. Club Am. **14**: 26–31. Mr 1931.

Holm, T. The apparent influence of inulin on the meristem in roots of Compositae. Beih. Bot. Centralbl. **47**: 359–377. *f. 1–17*. F 1931.

Hortleder, A. Some anatomical features of *Sorbopyrus auricularis*. Trans. Kansas Acad. Sci. **33**: 29–30. 1930.

Hurley, C. C. The friendly mesquite. Desert **7**: 141, 147. *illust.* Mr 1931.

Jackson, H. S. The rusts of South America based on the Holway collections. III. Mycologia **23**: 96–116. *pl. 11+f. 1–5*. 2 Mr 1931. IV. 332–364. *f. 1–6*. 1 S 1931.

Jensen, H. L. The fungus flora of the soil. Soil Sci. **31**: 123–158. F 1931.

Johansen, D. A. *Idria columnaris*. Desert **2**: 144, 145. Mr 1931.

Johnson, A. T. Some spring flowers of special merit. Gard. Chron. Am. **35**: 47, 55. *illust.* F 1931.

Johnston, C. O. Some new or unusual disease developments on wheat in Kansas. Trans. Kansas Acad. Sci. **33**: 31–40. 1930.

Jones, A. T. Trees with twisted bark. Science II. **73**: 341. 27 Mr 1931.

Jones, M. E. The species of the Cactus family. Desert **2**: 140, 142. *illust.* Mr 1931.

Karper, R. E. Multiple seeded spikelets in sorghum. Am. Jour. Bot. **18**: 189–194. *f. 1, 2.* 23 Mr 1931.

Kearney, T. H. Plants new to Arizona (an annotated list of species added to the record flora of the State or otherwise interesting). Jour. Washington Acad. Sci. **21**: 63–80. 4 Mr 1931.

Kelley, A. P. The concept of mycorrhiza. Mycologia **23**: 147–151. 2 Mr 1931.

Koch, L. W. Spur blight of raspberries in Ontario caused by *Didymella applanata*. Phytopathology **21**: 247–287. *f. 1–11.* Mr 1931.

Kulkarni, C. G. Inheritance studies of white-capping in yellow Dent maize II. Papers Michigan Acad. Sci. **13**: 111–129. Mr 1931.

Lamson, R. W. Evidence of biologic relationships among species of Chenopodiales. Proc. Soc. Exp. Biol. & Med. **28**: 502–504. 1931.

La Rue, C. D. The water supply of the epidermis of leaves. Papers Michigan Acad. Sci. **13**: 131–139. Mr 1931.

Linder, D. H. Brief notes on the Helicosporeae with descriptions of four new species. Ann. Missouri Bot. Gard. **18**: 9–16. *pl. 2+f. 1, 2.* F 1931.

Linder, D. H. The genus *Helicoceras*. Ann. Missouri Bot. Gard. **18**: 1–8. *pl. 1.* F 1931.

Lindford, M. B. Yellow-spot disease of pineapples transmitted by *Thrips tabaci* Lind. Science II. **73**: 263. 6 Mr 1931.

Lloyd, F. E. The range of structural and functional variation in the traps of *Utricularia*. Flora II. **25**: 260–276. *f. 1–13.* 1931.

Lohman, M. L. A study of *Glonium parvulum* in culture. Papers Michigan Acad. Sci. **13**: 141–156. *pl. 29–31.* Mr 1931.

McArdle, R. E. Determining the identity of mycorrhiza-forming fungi. Papers Michigan Acad. Sci. **13**: 159–164. Mr 1931.

McClintock, B., & Hill, H. E. The cytological identification of the chromosome associated with the R-G linkage group in *Zea Mays*. Genetics **16**: 175–190. *f. 1–4*. Mr 1931.

McCrea, A. Longevity of conidia of common fungi under laboratory conditions. Papers Michigan Acad. Sci. **13**: 165–167. Mr 1931.

McCully, A. American alpines in the garden. i–xii, 1–251. *illust.* New York, Macmillan Co., 1931.

Mangelsdorf, P. C., & Fraps, G. S. A direct quantitative relationship between vitamin A in corn and the number of genes for yellow pigmentation. Science II. **73**: 241–242. 27 F 1931.

Markwardt, L. J. The distribution and the mechanical properties of Alaska woods. U. S. Dept. Agr. Tech. Bull. 226: 1–79. *pl. 1–9+f. 1–7*. F 1931.

Melchers, L. E. Wheat mosaic in Egypt. Science II. **73**: 95–96. 23 Ja 1931.

Metcalf, F. P. Herbaria in China. Part I. Lingnan Sci. Jour. **9**: 351–356. D 1930.

Miller, M. R. The toxicity of *Corydallis caseana*. Jour. Agr. Res. **42**: 239–243. 15 F 1931.

Miller, P. A., & Barrett, J. T. Cantaloupe powdery mildew in the Imperial Valley. California Agr. Exp. Sta. Bull. 507: 1–36. *f. 1–13*. F 1931.

Moldenke, H. N. Three new species of *Aegiphila* from Central America. Trop. Woods **25**: 12–17. 1 Mr 1931.

Moore, C. S., & Moore, L. B. Some desmids of the San Juan Islands. Publ. Puget Sound Biol. Sta. **7**: 391–392. 30 D 1930.

Morgan, W. P. Flower forms in hybrid Freesias. Jour. Heredity **21**: 483–488. *f. 1–4+frontispiece*. D 1930.

Morris, F. Lady slippers of eastern North America. New Flora & Silva **3**: 77–81. *pl. 26–30*. Ja 1931.

Moseley, E. L. Some plants that were probably brought to northern Ohio from the west by Indians. Papers Michigan Acad. Sci. **13**: 169–172. Mr 1931.

Mumm, W. J., & Woodworth, C. M. Heritable characters in maize. XXXVI. A factor for soft starch in Dent corn. Jour. Heredity **21**: 503–505. *f. 9, 10*. D 1930.

Norton, A. H. *Littorella americana* in Washington County, Maine. Rhodora **33**: 79. 7 Mr 1931.

Osterhout, W. J. V., & Hill, S. E. Electrical variations due to mechanical transmission of stimuli. Jour. Gen. Physiol. **14**: 473–485. *f. 1–12*. 20 Mr 1931.

Overholts, L. O. Diagnoses of American Porias—III. Some additional brown species, with a key to the common brown species of the United States and Canada. Mycologia **23:** 117–129. *pl. 12–14.* 2 Mr 1931.

Palmer, E. F. Haphazard vs. studied crosses. Gladiolus Rev. **8:** 70–72. *illust.* F 1931.

Parker, K. W., & Sampson, A. W. Growth and yield of certain Gramineae as influenced by reduction of photosynthetic tissue. Hilgardia **5:** 361–381. *f. 1–8.* Mr 1931.

Perry, L. M. Concerning a California *Convolvulus.* Rhodora **33:** 76–77. 7 Mr 1931.

Phillis, E. Cotton notes. Transport of nitrogenous substances in the cotton plant. Jour. Imp. Col. Trop. Agr. **8:** 36–37. F 1931.

Povah, A. H. Fungi of Rock County, Michigan. Papers Michigan Acad. Sci. **13:** 173–189. *f. 12–14.* Mr 1931.

Quisenberry, K. S. Inheritance of winter hardiness, growth habit, and stem-rust reaction in crosses between Minhardi winter and H-44 spring wheats. U. S. Dep. Agr. Tech. Bull. 218: 1–43. *pl. 1–3+f. 1–5.* Ja 1931.

Randolph, J. F. Vector methods as a basis for mathematical formulation of the data of *Oenothera* genetics. Papers Michigan Acad. Sci. **13:** 191–211. *f. 15–26.* Mr 1931

Raup, L. C. The lichen flora of the Shelter Point region, Athabasca Lake. Bryologist **33:** 57–66. *pl. 6–9.* "S 1930" 13 Mr 1931.

Rawlins, T. E., & Horne, W. T. "Buckskin," a destructive graft-infectious disease of cherry. Phytopathology **21:** 331–335. *f. 1, 2.* Mr 1931.

Reynolds, E. S. Studies on the physiology of plant disease. Ann. Missouri Bot. Gard. **18:** 57–95. *f. 1.* F 1931.

Rhoades, M. M. Cytoplasmic inheritance of male sterility in *Zea Mays.* Science II. **73:** 340–341. 27 Mr 1931.

Richards, B. L., & Tompkins, C. M. The late blight of the sugar beet. Phytopathology **21:** 289–314. *f. 1–4.* Mr 1931.

Roldan, E. F. Bacterial stem-rot disease of hybrid seedling canes. Science II. **73:** 186. 13 F 1931.

Rudolph, B. A. *Verticillium* hadromycosis. Hilgardia **5:** 197–353. *pl. 1–4.* Mr 1931.

Sameshima, J. Succulent plants in Japan. Desert **2:** 143. *illust.* Mr 1931.

Schaffner, J. H. Principles of plant taxonomy. IX. Ohio Jour. Sci. **30:** 261–272. *f. 1–3.* Jl 1930: X. Ohio Jour. Sci. **31:** 77–96. Mr 1931.

Schlechter, R. Blütenanalysen neuer Orchideen. I. Südamerikanische Orchideen. Reprt. Spec. Nov. Beih. **58**: *pl. 1–60*. 15 S 1930; II. Mittelamerikanische Orchideen. Repert. Spec. Nov. Beih. **59**: *pl. 1–47*. 1 Mr 1931; *pl. 49–81*. 1931.

Schmidt, P. *Poinsettia pulcherrima* der mexikanische Weihnachtsstern. Gartenflora **80**: 1–2. *illust.* Ja 1931.

Sharp, A. J. Extension of the ranges for three rare mosses. Bryologist **33**: 69. "S 1930" 13 Mr 1931.

Shaw, M. C. The tree of mystery. Gard. Chron. Am. **35**: 87–88. *illust.* Mr 1931.

Washington fan palm.

Shull, J. M. Rainbow fragments. A garden book of the *Iris* with illustrations in full color. 1–317. *illust.* Garden City, N. Y. Country Life Press, 1931.

Small, J. K. Altitudinal distribution of eastern American *Iris*. Jour. N. Y. Bot. Gard. **32**: 49–66. *f. 1–10*. Mr 1931.

Small, J. K. Palms of the continental United States. Sci. Monthly **32**: 240–255. *illust.* Mr 1931.

Steere, W. C. *Meesea triquetra*. Rhodora **33**: 77–79. *pl. 205*. 7 Mr 1931.

Steere, W. C. *Petunia Parodii*, a new species of the subgenus Pseudonicotiana from Argentina. Papers Michigan Acad. Sci. **13**: 213–215. *pl. 32–34*. Mr 1931.

Steinmetz, F. H. A new station for *Littorella americana*. Rhodora **33**: 79–80. 7 Mr 1931.

Stevens, F. L. The ascigerous stage of *Colletotrichum lagenarium* induced by ultra-violet irradiation. Mycologia **23**: 134–139. *f. 1–3*. 2 Mr 1931.

Stevens, N. E. The spread of cranberry falseblossom in the United States. U. S. Dep. Agr. Circ. 147: 1–18. *f. 1, 2*. Ja 1931.

Steyermark, J. A. A study of plant distribution in relation to the acidity of various soils in Missouri. Ann. Missouri Bot. Gard. **18**: 41–55. F 1931.

St. John, H. New and noteworthy northwestern plants. Part IV. Proc. Biol. Soc. Washington **44**: 29–36. 21 F 1931. Part 5. State Coll. Washington Res. Stud. **2**: 110–116. *illust.* "S 1930" 15 Ja 1931.

Stout, A. B. The inter-relations between vegetative propagation and seed reproduction. Rep. & Proc. Ninth Internat. Hort. Congr. **1930**: 187–196. 1931.

Taylor, W. R. A synopsis of the marine algae of Brazil. Rev. Algol. **5**: 279–313. 1931.

Tilford, P. E. *Gladiolus* diseases. Ohio Agr. Exp. Sta. Bull. 149: 67–72. *f. 1–5.* Mr–Ap 1931.

Toro, R. A. Nuevas enfermedades de la palma de coco en Puerto Rico. Rev. Agr. Puerto Rico **26:** 42–43. *f. 1–6.* F 1931.

Tupper, W. H. An unusual seasonal growth ring in *Eucalyptus.* Papers Michigan Acad. Sci. **13:** 217–219. *pl. 35.* Mr 1931.

Uppal, B. N., & Desai, M. K. Physiologic specialization in *Sclerospora graminicola.* Phytopathology **21:** 337–338. Mr 1931.

Urban, I. Plantae Haitienses et Domingenses novae vel rariores IX. a. cl. E. L. Ekman 1924–1930 lectae. Ark. Bot. **23A**[11]**:** 1–103. *pl. 1–5.* 1931.

Victorin, Marie-(Frère). *L'Anacharis canadensis.* Histoire et solution d'un imbroglio taxonomique. Contr. Lab. Bot. Univ. Montreal 18: 1–43. *f. 1–7.* 1931.

Walker, R. L. Fertilization and embryo-development in *Hesperophycus Harveyanus.* La Cellule **40:** 175–192. *pl. 1–3 +f. 1, 2.* 1931.

Wallace, G. B. A coffee bean disease. Jour. Imp. Col. Trop. Agr. **8:** 14–17. Ja 1931.

Wallace, R. H. Studies on the sensitivity of *Mimosa pudica.* I. The effect of certain animal anesthetics upon sleep movements. Am. Jour. Bot. **18:** 102–111. *pl. 9.* F 1931; II. The effect of animal anesthetics and certain other compounds upon seismonic sensitivity. 215–235. *pl. 20+f. 1–6.* 23 Mr 1931; III. The effect of temperature, humidity, and certain other factors upon seismonic sensitivity. 288–307. *f. 7–13.* 15 Ap 1931.

Wardlaw, C. W. *Fusarium cubense.* Jour. Imp. Col. Trop. Agr. **8:** 54–60. *f. 1.* Mr 1931.

Waugh, F. A. Ecology of the roadside. Land. Arch. **21:** 81–92. *illust.* Ja 1931.

Weatherby, C. A. An island variety of *Cheilanthes peninsularis.* Am. Fern Jour. **21:** 25–26. Ja–Mr 1931.

Weber, C. The flora of Clay County, Kansas. Trans. Kansas Acad. Sci. **33:** 87–106. 1930.

Weberbauer, A. Über die Polsterpflanze *Pycnophyllum aristatum* und die Polsterpflanzen im allgemeinen. Ber. Deutsch. Bot. Gessell. **49:** 29–34. 26 F 1931.

Welch, M. B. Queensland "maple" (*Flindersia* spp.) Trop. Woods **25:** 18–24. 1 Mr 1931.

Wentworth, C. K. Twist in the grain of coniferous trees. Science II. **73:** 192. *f. 1.* 13 F 1931.

Werdermann, E. Die Pflanzenwelt Nord- und Mittelchiles. Vegetationsbilder **21:** *pl. 31–42.* 1931.

Wherry, E. T. A new spiral-orchid from the southern states. Jour. Washington Acad. Sci. **21**: 49–51. 19 F 1931.

Williams, L. The forests of northeastern Peru. Trop. Woods **25**: 5–12. 1 Mr 1931.

Wittrock, G. L. *Poncirus trifoliata*. Addisonia **15**: 59–60. *pl. 510*. "D 1930" 12 Mr 1931.

Woodcock, E. F. Morphological studies on the seed of *Mesembrianthemum crystallinum* L. Papers Michigan Acad. Sci. **13**: 221–226. *pl. 36, 37*. Mr 1931.

Wright, S. Evolution in Mendelian populations. Genetics **16**: 97–159. *f. 1–21*. Mr 1931.

Young, P. A., & Morris, H. E. Researches on potato-virus diseases in Montana. Montana Agr. Exp. Sta. Bull. 231: 1–51. *f. 1–7*. Je 1930.

Zahlbruckner, A. A new *Haematomma* from Florida. Bryologist **33**: 31. "My 1930" 7 Ja 1931.

Haematomma Rappii sp. nov. is described.

Zanini, C. J. Sobre un Actinomices aislado de Vacuna. Bol. Minist. Agr. Rep. Argentina **29**: 317–325. *f. 1–9*. S 1930.

Zeller, S. M. Contribution to our knowledge of Oregon fungi-III. Mycologia **21**: 97–111. *f. 1–3*. 1 Mr. 1929.

Zirkle, C. Nucleoli of the root tip and cambium of *Pinus Strobus*. Cytologia **2**: 85–105. *pl. 3–6*. Mr 1931.

Phoma conidiogena, an excitant of asthma: some observations on the development and cultural characteristics

RHODA W. BENHAM

(WITH PLATES 14–16 AND EIGHT TEXT FIGURES)

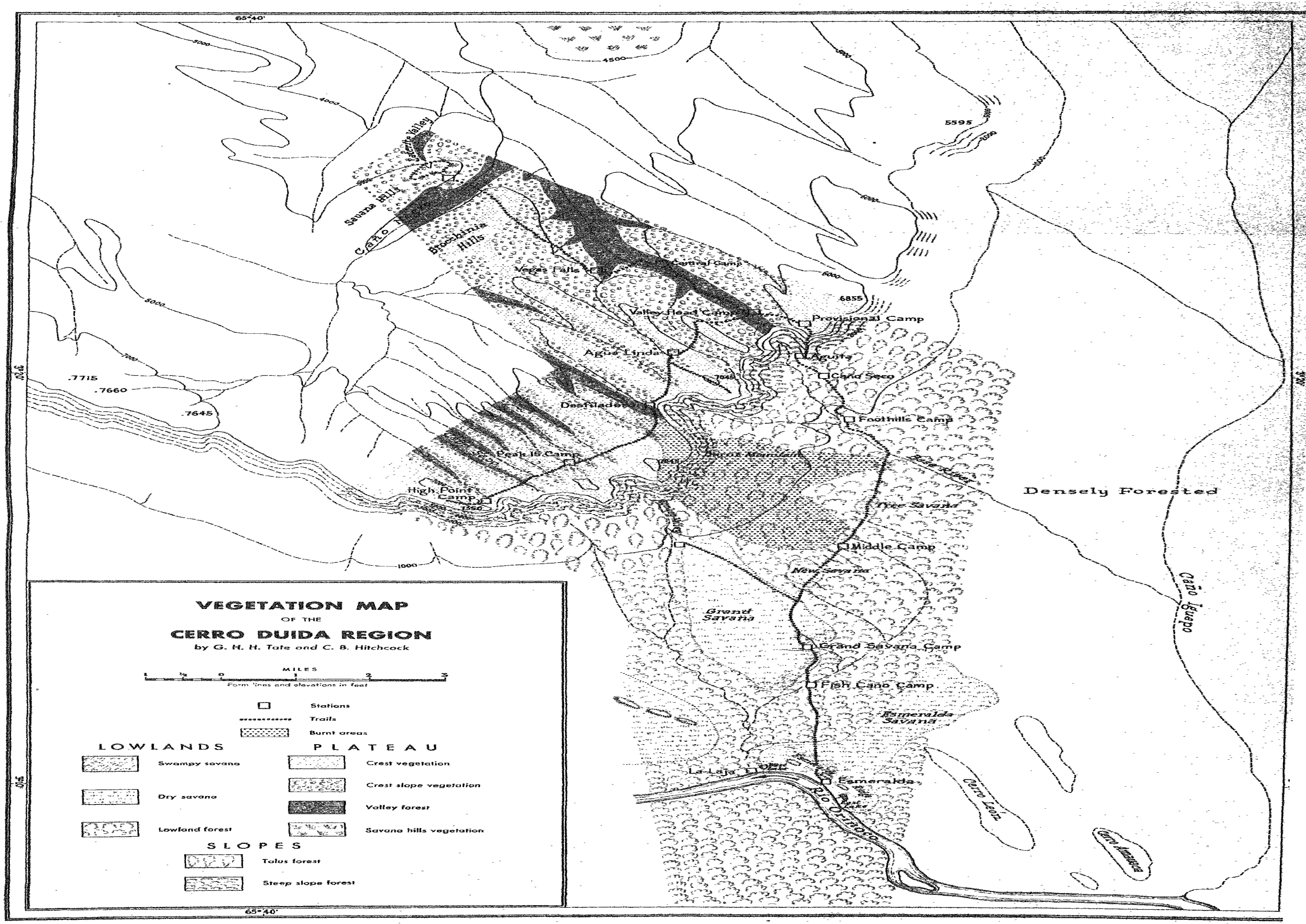
The fungus, a *Phoma*, which has been made the object of this study belongs to the Sphaeropsidales of the Fungi Imperfecti, having the asexual spores borne in a more or less globular fruit body, known as a pycnidium. It was obtained during an investigation of a case of asthma due to a fungus, being one of a number of forms which occurred on Petri dish cultures of maltose agar (Sabouraud) after exposure in places where the patient's asthmatic attacks were most severe. The fungus to which the patient had been shown to be most sensitive was an *Alternaria*, probably *Alternaria Mali* (Hopkins, Benham, and Kesten, 1930). Tests were made to see whether this *Phoma* form would produce asthmatic attacks; such was found to be the case: a most severe attack followed spraying the throat with an extract of this fungus. Skin sensitization was also shown. Interest was aroused in the culture, as it was found to have, associated with the pycnidial form, dark septate structures borne singly or in chains, resembling spores of *Macrosporium* and *Alternaria*.

A study was undertaken to determine the relation of the cells of the *Alternaria*-like form to the life cycle of the fungus. A brief report of the developmental and cultural characteristics of the strain follows.

Planchon (1900), in a study on the effect of various media on the growth of some dematious fungi, described a form which appears to be very like, if not identical with this fungus. He called his fungus *Alternaria polymorpha* because of its great variation in form. Planchon noted the formation of the pycnidium from a single cell, either from a cell of the yeast form which he described, or from a germinating pycnospore, or as he termed it, stylospore.

Schnegg (1915), in his study on the development and biology of pycnidia, gave a complete picture of the cultural characteristics and pycnidial development of a fungus which is also similar. He called it *Phoma conidiogena*, because of the type of pycnidial formation, which he described and illustrated very clearly. The pycnospores or conidia gave rise, by growth and division, to the mature pycnidium. He studied the fungus in hanging drop cultures and was able to trace the development of the pycnidium from the germinating spore. Von Tavel (1889) noted the formation of a pycnid-

[THE BULLETIN FOR MARCH (58: 127–202) WAS ISSUED 22 OCTOBER 1931.]



VEGETATION MAP
OF THE
CERRO DUIDA REGION
by G. H. H. Tate and C. B. Hitchcock
MILES
Form lines and elevations in feet
Stations
Trails
Burnt areas
LOWLANDS
Swampy savana
Dry savana
Lowland forest
PLATEAU
Crest vegetation
Crest slope vegetation
Valley forest
Savana hills vegetation
SLOPES
Talus forest
Steep slope forest
65°40'
Savana Hills
Laterite Valley
Caño
Brocchinia Hills
Vegas Falls
Central Camp
Valley Head Camp
Provisional Camp
Agua Linda
Aguita
Caño Seco
Desfiladero
Foothills Camp
Peak 15 Camp
High Point Camp
Tree Savana
Middle Camp
New Savana
Grand Savana
Grand Savana Camp
Fish Caño Camp
Esmeralda Savana
La Laja
Esmeralda
Rio Orinoco
Cerro Leon
Caño Iguepo
Densely Forested
5595
6855
.7715
.7660
.7645
4500
5000
4000
1000

m from a single ascospore of *Cucurbitaria Platani*, and referred to it as a ›oro-pycnidium.

Planchon observed, as did Schnegg, that there are two types of pycnid-l formation, that mentioned above, and the formation of the pycnidium om a cell or cells of a hypha. This later type Schnegg called secondary ycnidia. The development was, for the most part, according to Schnegg, f the meristogenetic type, though there may be also a combination of the ıeristogenetic and symphyogenetic types. Bauke (1876) had clearly de-cribed these two methods by which pycnidia may be formed. Kempton 1919) likewise gave a complete description of pycnidial formation for a ıumber of forms and distinguished these types.

In addition to pycnidial formation, Planchon observed in his cultures ɔodies resembling the conidia of *Macrosporium* or *Alternaria*. Schnegg, too, wrote of the dark, thick-walled cells which resembled conidia of *Septosporium* or *Macrosporium* which he called 'Dauerzellen.' These developed from cutinized portions of the mycelium. More recently Brooks and Searle (1920), in an investigation of tomato mosaic, mentioned the discovery of a similar fungus which they named *Phoma alternariaceum*. This formed both pycnidia and *Alternaria*-like spores. This same strain was studied by Chodat (1926), who noted the similarity of the septate structures to spores of *Alternaria*. Brooks and Searle refer to two other species of *Phoma* in which *Alternaria*-like forms had been described: these were *Phoma Richardiae* and *Phoma fictilis*. They were included in a list of *Phoma* cultures described by Westerdijk and Van Luijk (1920).

GENERAL MORPHOLOGY AND CULTURAL CHARACTERISTICS OF THE PHOMA STUDIED

he fungus produces a heavy, septate mycelium which shows frequent branching and anastomosing. There is but slight production of aerial mycelium, and this varies greatly with the medium offered, being more abundant on media containing sugars, much less on Czapek's agar, and greatly reduced on corn meal. The greatest production of aerial mycelium occurs on wort agar. On this medium the fungus grows very compactly with thick short tufts of aerial hyphae. The pycnidia appear very soon after inoculating a culture, usually in 48 hours, and were abundant on all of the media used. The pycnidia were arranged more or less irregularly over the surface of the colony, lying between the hyphal branches. The shape and size shows great variation. They may be very elongated, oval, or spherical in form, usually with one ostiole, though sometimes two may be noted. The pycnospores, which are small, one-celled, usually hyaline spores, oval in

shape, appear in two to three days. Their size also varies with the medium used. They escape through the ostiole and accumulate about the opening in a more or less gelatinous or slimy mass (fig. 2). On sugar media or Czapek's agar the color is rose to pink as they are first formed, so that one notes these slimy colored masses scattered over the whole colony. Later the color changes to brown, then black. On corn meal agar, however, the pink color never appears, the entire growth is more scanty, the pycnidia as they form are quite separate, and the masses of spores appear tan-colored rather than rose-colored. They are golden to light brown at first and darken with age. Some of the spores appear to be quite dematious in character. Occasionally one finds dark spores that are two celled (fig. 1, B). The dark-colored septate structures resembling *Alternaria* spores appear somewhat later than the pycnidia. They begin to form usually at the end of a week, and are more abundant in the drier portions of the culture. They occur singly at the ends of lateral branches of the mycelium, or in long chains closely surrounding the pycnidia. They may be more or less simple in form as shown in figure 3 or more complex as in figure 4. They are usually thick-walled, highly granular, and of deep brown to black color. At the time that these cells form, the entire mycelium may become highly granular and show thickening of the cell walls, giving the appearance of chains of chlamydospores. These thick-walled cells darken, giving a comparatively simple form of resistant cells. Frequently one finds the peculiar hyphal coils so often present in fungus cultures which Schnegg pictures so carefully and terms 'Mycelschlengen.' Schnegg notes that the pycnospores also formed resistant cells, the 'Dauerconidia.' This is probably what is happening in the case of the two-celled, dark pycnospores mentioned above.

COLONY CHARACTERISTICS

The gross appearance of the colonies on various media may be seen in plate 15. On dextrose or honey agar, as noted above, the pycnidium formation is very abundant (fig. 10). The pycnospores escape and collect in great masses at the openings of the pycnidia. The pycnidia appear to run together and one finds a continuous border of shiny moist substance, consisting of spores, at first pink, later dark brown around the colony. A slight development of aerial mycelium is noted at the center and outer border of the colony. In two months old cultures the whole surface is covered with aerial mycelium (fig. 11).

On Czapek agar the aerial growth is more scanty. On this medium, also, as the pycnidia form and the spores are discharged, there is a decided rose-color to the colony. Later this color changes to brown, then black as noted above. A very excellent example of sectoring, or what Chodat called

saltation or mutation occurred (fig. 6). Two of these sectors were much darker in color and more compact in growth than the rest of the colony. These darker areas are made up of masses of the *Alternaria*-like spores with very few pycnidia, whereas the pycnidia are more abundant in the lighter areas. Transfers from these sectors and from the lighter portions of the

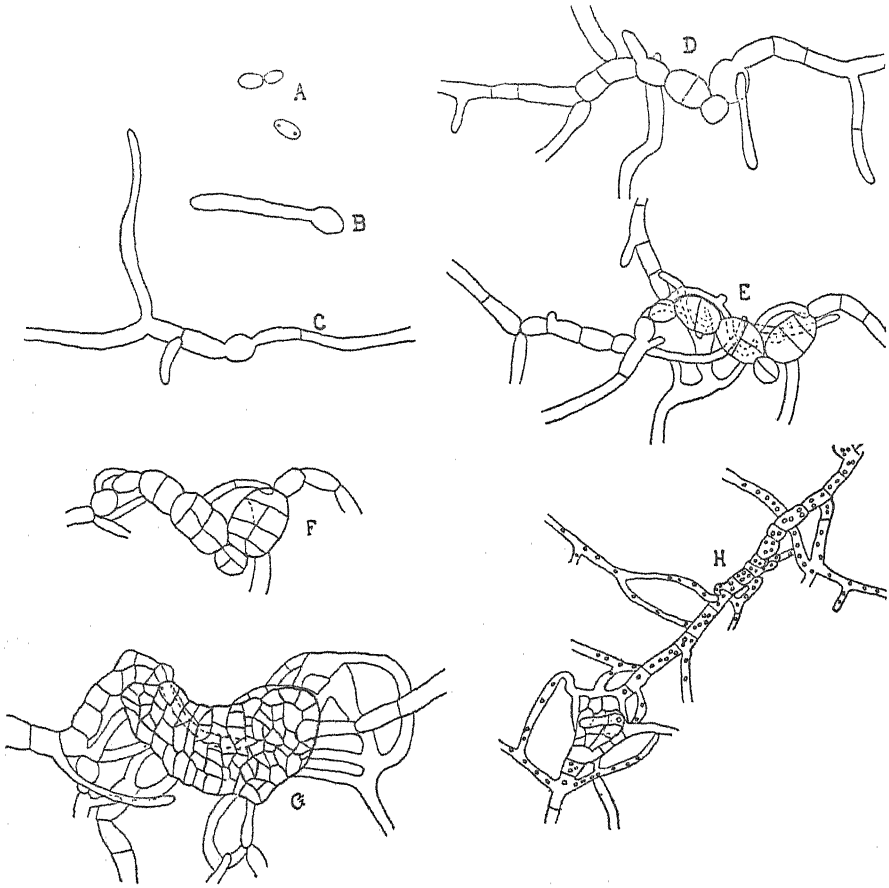


Fig. 12. Development of the pycnidium from a single pycnospore. (a) Mature pycnospore. (b) Germinating pycnospores after ten hours. (c) At 24 hours. (d) At 28 hours. (e) At 30 hours. (f) At 31 hours, and (g) at 34 hours. (h) Pycnidium formation from a hyphal cell. ×1500.

colony produce both pycnidia and muriform cells. The colonies obtained from the darker areas show a greater tendency to sector in turn, than those obtained from the lighter areas, or more normal portions of the colony. Chodat noticed this sectoring and followed carefully the further develop-

ment of the strains thus obtained, and reports a number of permanent races or mutants. Chodat concluded from his study that on media deprived of sugar it was more difficult to detect differences in his races.

On corn meal agar there is little growth of aerial mycelium but there is abundant production of pycnidia and *Alternaria*-like cells. This seems a favorable medium for the study of the organism as the mycelial growth is less abundant, and the medium being more or less transparent, development of fruiting structures can be watched closely. The pycnidia develop rapidly, being completely formed in two or three days. The mycelium is at first colorless, then as the pycnidia form, brownish spots can be observed scattered over the plate (fig. 7). At the center of the plate the pycnidia are irregularly scattered, but farther out, tend to form in zones, the colony being composed of numerous concentric rings (fig. 8). On plates three weeks or more old, the outer ring or border of the colony is much darker than the central portion, due to the greater production of the *Alternaria*-like cells in this region (fig. 9). There is also some tendency to sector on this medium. The color on corn meal is more of an olive green than brown or black. The *Alternaria*-like cells usually begin to appear at the end of a week or ten days and are very abundant in plates three to four weeks old. The pycnidia tend to be more spherical in shape on this medium (fig. 4) and somewhat smaller than on the sugar media. The pycnidium may be oval, having dimensions 64×80 microns, or spherical, 80 to 100 microns or more in diameter.

A few transfers were made to sterilized rose leaves and cherry twigs. On these the growth was very dark and consisted primarily of thick-walled brownish-black mycelia with abundant production of the *Alternaria*-like cells (fig. 5). Pycnidium development was greatly reduced.

MONOSPORE CULTURES

The fact that the muriform cells and the pycnidia were derived from the same mycelium was established by Brooks and Searle, who obtained monospore strains from pycnospores, which in turn produced both pycnidia and *Alternaria*-like structures. A single muriform cell was germinated, and it likewise produced both types of spores. In the present study twenty-eight monospore strains were obtained, fourteen from germinating *Alternaria*-like cells and fourteen from pycnospores. All of these monospore strains gave abundant development of pycnidia and *Alternaria*-like cells. Slight variations could be noted in the strains as to the depth of color produced and the tendency to form resistant cells, although the general appearance of all the strains was similar on corn-meal agar. One mono-

spore strain was selected at random for a more complete study of the development of the pycnidium, and this was compared with the original culture from time to time.

DEVELOPMENT OF THE PYCNIDIUM

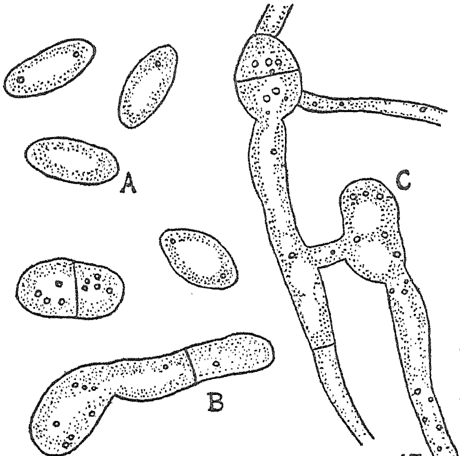
The development of the pycnidium was observed in hanging drops and in slide cultures. A drop of corn meal agar, or wort agar was placed on a cover slip or slide and inoculated with pycnospores, care being taken to have the sowing dilute. Observations were made from these cultures grown at room temperature. Within eight to twelve hours after sowing the spores germinate (fig. 12, B). At first one germ tube forms and several hours later the second one appears. Sometimes the pycnospores divide by a cross wall before germinating. The next step is the formation of a transverse wall in each germ tube, thus forming an elongated cell on each side of the original spore (fig. 12, C). The original spore and adjacent cells can readily be distinguished from the neighboring cells by their slightly thicker wall and more granular appearance. These cells continue to grow by transverse divisions in the original spore and in the adjacent cells. A chain of cells which are differentiated from the rest is formed (fig. 12, D). These are evidently the primordium of the pycnidium.[1] Side branches bud out from these cells and turn back to the primordium, thus forming the 'Hullhyphen' (Schnegg) which support and surround the pycnidium (fig. 12, E). Longitudinal walls now appear in the original spore and other cells of the chain (fig. 12, F). Development from here on is very rapid, division continuing until there is formed a compact, elongated parenchymatous mass of tissue which is readily recognized as a young pycnidium (fig. 12, G). The wall cells begin to darken and thicken. The process thus far takes about 48 hours. Within the next 24 hours ripe pycnospores are present and begin to discharge from the pycnidium. The pycnospores are oval to egg shape. At first the contents are homogeneous, later an 'oil drop' appears in each end of the spore (fig. 13). The spores are usually hyaline though dark spores have been noted at times; they vary in size depending somewhat upon the medium. From pycnidia found on corn meal they measured 5.35–5.8 microns$\times$2.3 microns. On wort they are somewhat larger, being 7.2×4 microns; this last measurement agrees with those of Schnegg for the pycnidial spores of *Phoma conidiogena* grown on wort agar. He gave the measurements 7×3.5 microns. The pycnidia, formed in this manner, are large and vary in shape.

[1] Kempton states that the term primordium is used to designate a group of cells that have become so differentiated that it is clearly evident that from these a pycnidium or similar structure will arise.

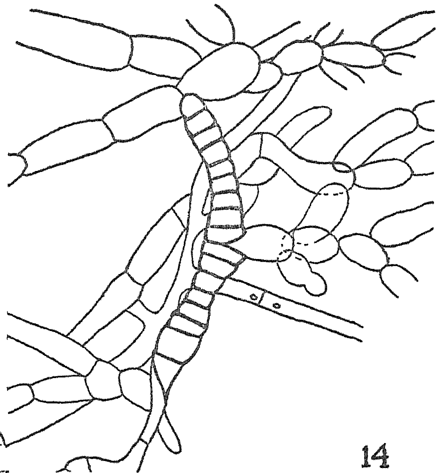
Most are elongated though some appear almost spherical. In hanging drop cultures and slide cultures not all of the pycnidia become mature, undoubtedly due to unfavorable conditions. An identical development of pycnidia was observed from a germinating spore of the original strain. The development of these strains corresponds minutely with the type of pycnidium formation described for *Alternaria polymorpha* by Planchon and for *Phoma conidiogena* by Schnegg. It may be said to represent the extreme meristogenetic type of pycnidial formation.

The second type of pycnidium formation noted by Planchon and by Schnegg was also observed. A cell of the mycelium may divide, increase in size, become more granular and the wall thicker, thus indicating that it is to be the primordium of a pycnidium. This then continues to divide by transverse and vertical walls until a compact mass of tissue forms (fig. 12, H). Sections of early stages of pycnidia formed in this manner are shown in figures 15 and 16. Side branches from neighboring cells of the hyphae form and grow in toward the primordium. Sometimes branches from neighboring hyphae may take part in the development of this wall. Development here then is either of the simple meristogenetic type or a mixture of the meristogenetic and symphyogenetic types. The pycnidia formed by the second method are usually smaller than the others and tend to be spherical in shape. Usually there is one ostiole to each pycnidium and the spores when ripe, may be seen to escape one by one, often in a steady stream. Once free in the culture, as stated above, the spores appear to accumulate around the ostiole in a mass as if they were held together in some gelatinous matrix. Occasionally the pycnidium may be compound and form two or more ostioles. These pycnidia are usually irregular in shape and no doubt more than one primordium was involved in their origin. The wall of the pycnidium is dark in color, though the intensity varies with the medium.

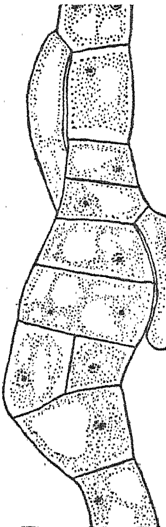
The *Alternaria* type of cell rarely appears in slide cultures where pycnidia are abundant. They begin to appear, however, in cultures ten days or more old. Occasionally it was noted that if insufficient water was placed in the hanging drop culture, the pycnospore started to germinate and then terminated very rapidly in a dark-colored septate structure. This formation of resistant cells and spores varied. Often chains of highly granular, thick-walled, dark-colored chlamydospores appeared. The formation of these from the hyaline mycelium could be traced. The cells became more granular, developed more cross walls, with a thickening and darkening of the walls. Some of these cells then increased in size and developed longitudinal walls, thus forming the *Alternaria*-like structures. These cells often



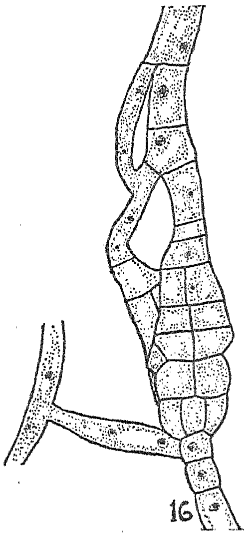
13



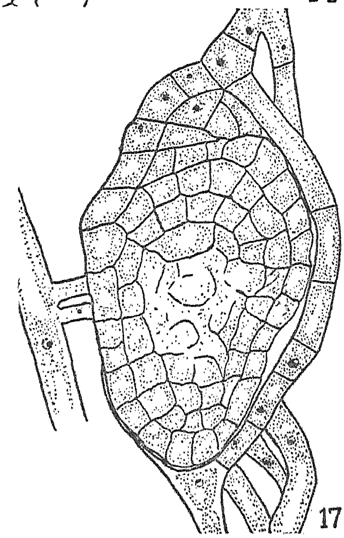
14



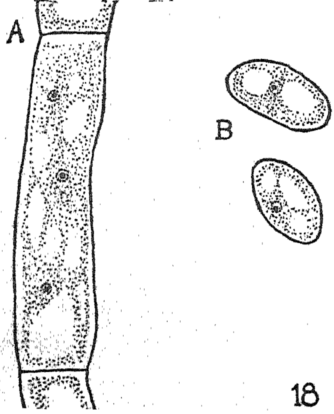
15



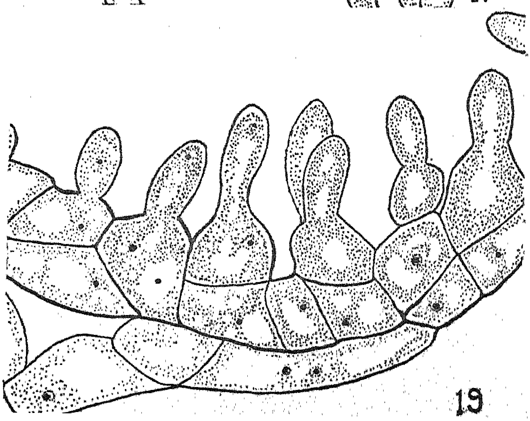
16



17



18



19

appeared in chains of 8 or 10 or more. A germinating *Alternaria*-like cell is shown in figure 14. Further development of the pycnidium was studied from fixed and stained material.

CAVITY FORMATION IN THE PYCNIDIUM

Cultures from corn-meal agar plates were fixed in Flemming's weak solution diluted with an equal quantity of water and the addition of a drop of acetic acid. Sections showed that the cells of the hyphae are multinucleate and the septa numerous (fig. 18, A). Anastomosing was noted frequently. The cavity formation was not studied extensively, but appeared to begin by a breaking down of the tissue at the center of the small pycnidial knot (figs. 20–21). The cells next in line push toward the center and in turn disintegrate (figs. 17, 22). Elongated cells resembling sporophores are then observed extending into the cavity (figs. 23–24). These, the protosporophores, probably break down, though some of them may cut off spores (figs. 25–26). The cavity gradually increases in size and the tissue within it disappears until only a row of cells or sporophores is left inside the pycnidial wall. From these structures spores may be seen to form (figs. 19, 27, 28). Some stages show the sporophores extending into the cavity, which still contains stainable remains of the disorganized central tissue, suggesting perhaps that the food for the developing spores comes from within. In still older stages it is difficult to make out the sporophores. The mature pycnidium was found to consist of a definite wall of one or two layers, and the entire pycnidium filled with spores, arranged so that they pointed toward the center of the pycnidium with one end toward the ostiole. The spores appeared to be uninucleate and cut off from a sporophore extending into the pycnidial cavity (figure 18, B). The lysigenous cavity formation above described is similar to that described by Dodge (1923) for *Phyllostictina carpogena*. This is in contrast to schizogenous cavity formation where the cells of the central portion of the pycnidial primordium grow more slowly than those at the periphery, so that the cells at the center are torn apart. It would be difficult to exclude entirely growth inequalities in the present case, as it seems possible that they may have some influence in initiating the cavity formation.

Fig. 13. (a) Mature pycnospores. (b) Germinating pycnospores. (c) Anastomosing of germinating pycnospores. Fig. 14. Germinating *Alternaria*-like cell. Fig. 15. Early stage in development of a pycnidium from a hyphal cell as seen in section. Fig. 16. Later stage of development of pycnidia. Fig. 17. Median section of developing pycnidium, showing the breaking down of the tissue at the center. Fig. 18. (a) Section of a hyphal cell showing several nuclei. (b) Pycnospores showing nucleus. Fig. 19. Median section through mature pycnidium showing formation of spores from sporophores just inside the wall. All ×4000.

DISCUSSION

It would appear from this study that the species under discussion is similar to, if not the same as, that described by Schnegg. It would be very difficult unless one were able to study their cultures, to determine whether Planchon, Chodat, and Schnegg were dealing with the same species. If all had the same species the name given by Planchon (*Alternaria polymorpha*) would have priority. The fungus described is undoubtedly a *Phoma* and not an *Alternaria*, so that the name given by Schnegg, *Phoma conidiogena*, should have precedence, though the name *Phoma alternariaceum* might be preferable from a descriptive standpoint.

Most interesting and suggestive in this connection is the formation of the resting mycelium, such as was noted by De Bary (1887), in saprophytic forms. He states that

> It occurs in old and specially in starved mycelia, for example, of *Pleospora*, *Fumago*, and *Cucurbitaria*, in which the cells of the mycelium acquire thick and usually brown walls, store up reserve food material, and pass into a dormant state, and subsequently under suitable conditions, germinate as spores.

He then follows with a description of pycnidium formation, and mentions *Pleospora Alternariae* (Gibelli), stating that the identification of the species is not certain because of the absence of perithecia. A variety of forms seems to have been included under the name *Pleospora herbarum*, and it seems most probable that the species of that group which produces conidia of the *Alternaria* type might well be such a form as *Phoma conidiogena*. It would be interesting indeed if the perfect state of *Phoma conidiogena* proved to belong to the genus *Pleospora*.

SUMMARY

1. The fungus described belongs to the genus *Phoma*, possessing resistant cells similar in form to spores of *Alternaria*.

2. What appear to be similar species have been described previously by Planchon, Brooks and Searle, Schnegg, and Chodat.

3. Schnegg appears to be the first to place the fungus in the genus *Phoma*. This gives the name *Phoma conidiogena* precedence.

4. The development of the pycnidium from a single pycnospore has been traced. Upon germination the pycnospore forms two germ tubes. A cross wall forms in each tube, thus cutting off a cell on each side of the pycnospore. These cells and the pycnospore continue to divide until a chain of cells, differentiated by their thicker walls and more granular contents, is formed. These cells by continued growth and division form a

parenchymatous mass of tissue which develops into a pycnidium. This confirms the work of Planchon and Schnegg.

5. The formation of the cavity of the pycnidium and the production of the pycnospores has been studied. The cavity appears to originate by the breaking down of the tissue at the center of the pycnidial knot. The cells next in line push into the cavity thus made. These in turn disintegrate, and elongated cells or protosporophores extend into the cavity. The cavity increases in size by the breaking down of this sterile tissue. The mature pycnidium consists of one or two layers of wall cells, with a single sporophore layer, from which the pycnospores are cut off.

The writer is indebted to Professor J. Gardner Hopkins and Dr. B. O. Dodge for advice and criticism in the preparation of this paper.

Laboratory for Medical Mycology and Department of Dermatology,
College of Physicians and Surgeons,
Columbia University, New York

Literature cited

Bary, A. de. 1884. Vergleichende Morphologie und Biologie der Pilze, Mycetozoen und Bacterien. 558 p. *198 f.* Leipzig. [Eng. transl. by Garnsey and Balfour. 525 p. *198 f.* Oxford, 1887. (pp. 246–247).]

Bauke, H. 1876. Beiträge zur Kenntniss der Pycniden. Nova Acta K. Leop. Carol. Akad. Naturf. **38:** 443–512.

Brooks, F. F., and G. O. Searle. 1921. An investigation of some tomato diseases. Trans. Brit. Mycol. Soc. **7:** 173–197.

Chodat, F. 1926. Recherches experimentales sur la mutation chez les champignons. Bull. Soc. Bot. Geneve II. **8:** 41–144.

Dodge, B. O. 1923. Origin of the central and ostiolar cavities in pycnidia of certain fungous parasites of fruits. Jour. Agr. Res. **23:** 743–759.

Hopkins, J. G., R. W. Benham, and B. M. Kesten. 1930. Asthma due to a fungus—*Alternaria*. Jour. Am. Med. Assoc. **94:** 6–10.

Kempton, F. E. 1919. Origin and development of the pycnidium. Bot. Gaz. **68:** 233–261.

Planchon, L. 1900. Influences de divers milieux chimiques sur quelques champignons du groupe des Dématiées. Ann. Sci. Nat. Bot. VIII. **11:** 1–248.

Schnegg, H. H. 1915. Zur Entwicklungsgeschichte und Biologie der Pycniden, sowie der Schlingenmycelien und Hyphenknauel. Centralbl. Bact. 2 Abt. **43:** 326–364.

Tavel, F. von. 1889. Contributions to the history of the development of the Pyrenomycetes. Jour. Mycol. **5:** 181–184.

Weseterdijk, J., und A. van Luijk. 1920. Die Kultur der *Phoma*-Arten. Medeel. Phytopathol. Lab. Willie Commelin Scholten Amsterdam **4**^{3}**:** 26–30.

Explanation of plates

PLATE 14

Fig. 1. Germinating pycnospores from corn-meal agar slide. (a) Anastomosing of pycnospores. (b) Dark-colored septate pycnospore. ×1500.

Fig. 2. Photomicrograph of corn-meal agar plate showing pycnidia and *Alternaria*-like cells. (a) Pycnospores massed about the ostiole. ×150.

Fig. 3. Resistant cells resembling spores of *Alternaria*. ×1500.

Fig. 4. Mature pycnidium and *Alternaria*-like cells. ×500.

Fig. 5. Production of *Alternaria*-like cells on cherry twig. ×500.

PLATE 15

Fig. 6. Sectoring in a two weeks old culture on Czapek agar.

Fig. 7. One week old culture on corn-meal agar. Pycnidia appear as black dots scattered over the culture.

Fig. 8. Pycnidia formation in concentric rings on corn-meal agar plates.

Fig. 9. One month culture on corn-meal agar, showing the characteristic dark border.

Fig. 10. Culture on dextrose agar, two weeks old, showing the broad shining border around colony due to masses of pycnospores.

Fig. 11. Aerial mycelium on dextrose agar plate two weeks old.

PLATE 16

Fig. 20. Section through young pycnidial knot. ×700.

Fig. 21. Section through young pycnidial knot showing beginning of breaking down of cells at center; also orienting of cells toward the center. ×700.

Fig. 22. Later stage showing cavity at center of pycnidial knot. ×700.

Fig. 23. Median section through young pycnidium showing elongated cells extending into cavity. ×300.

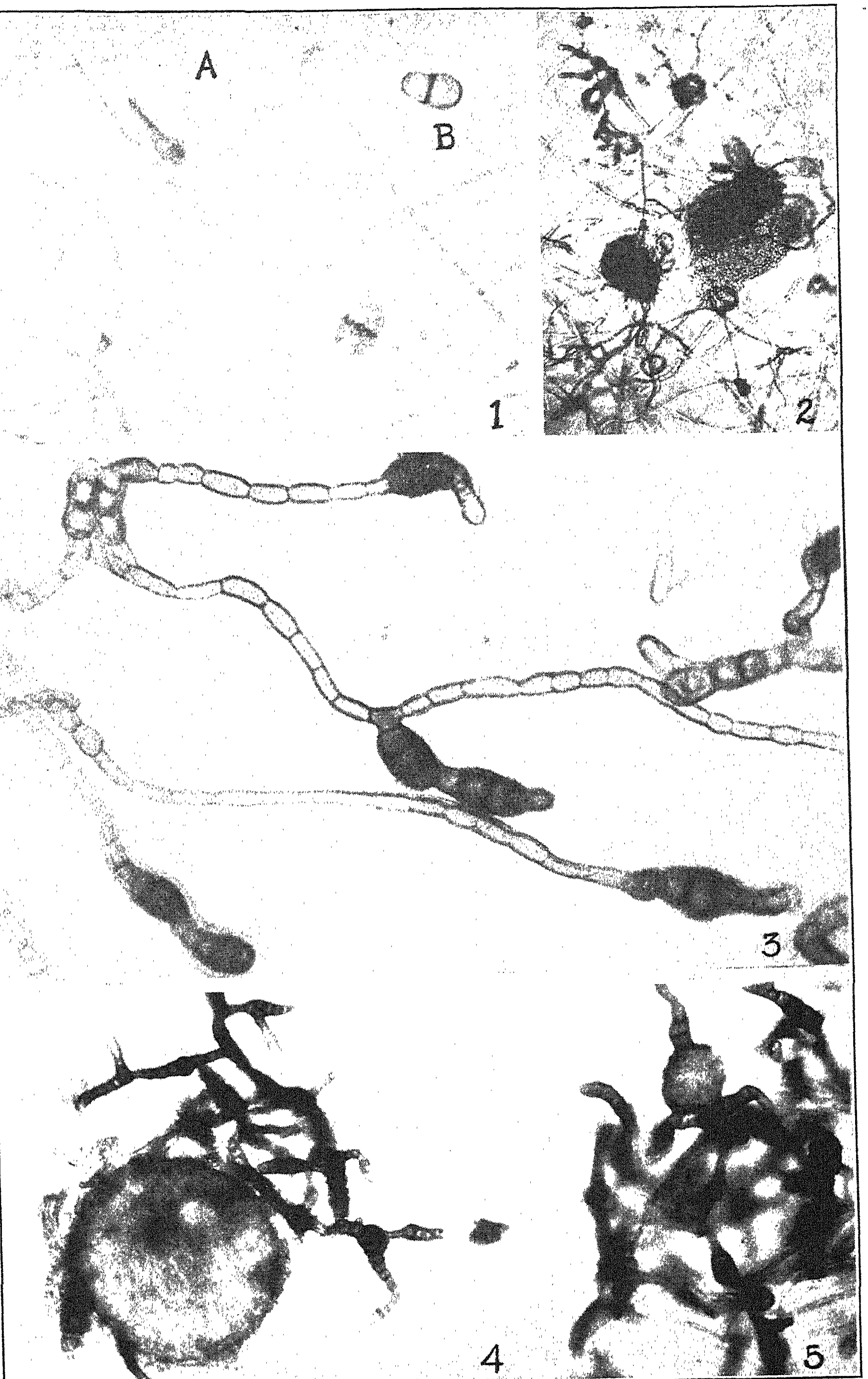
Fig. 24. Similar stage showing increase in size of cavity with border of elongated cells extending into the cavity. ×300.

Fig. 25. Median section showing cavity formation of ostiole. ×300.

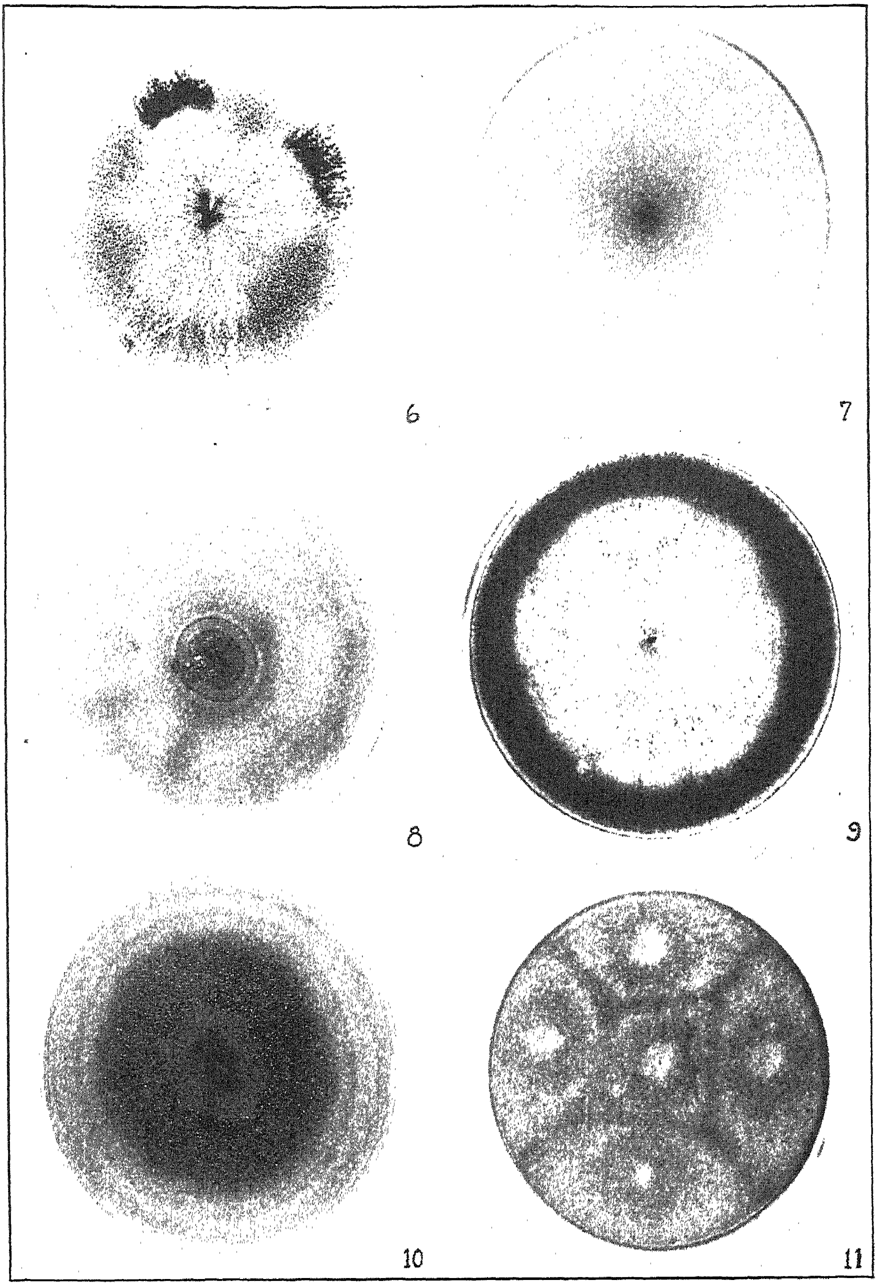
Fig. 26. Median section of pycnidium. Elongated cells or protosporophores extending into the cavity. Some mature spores in the cavity. ×300.

Fig. 27. Median section of mature pycnidium showing wall of two layers with spores arising from sporophore just inside the wall. ×700.

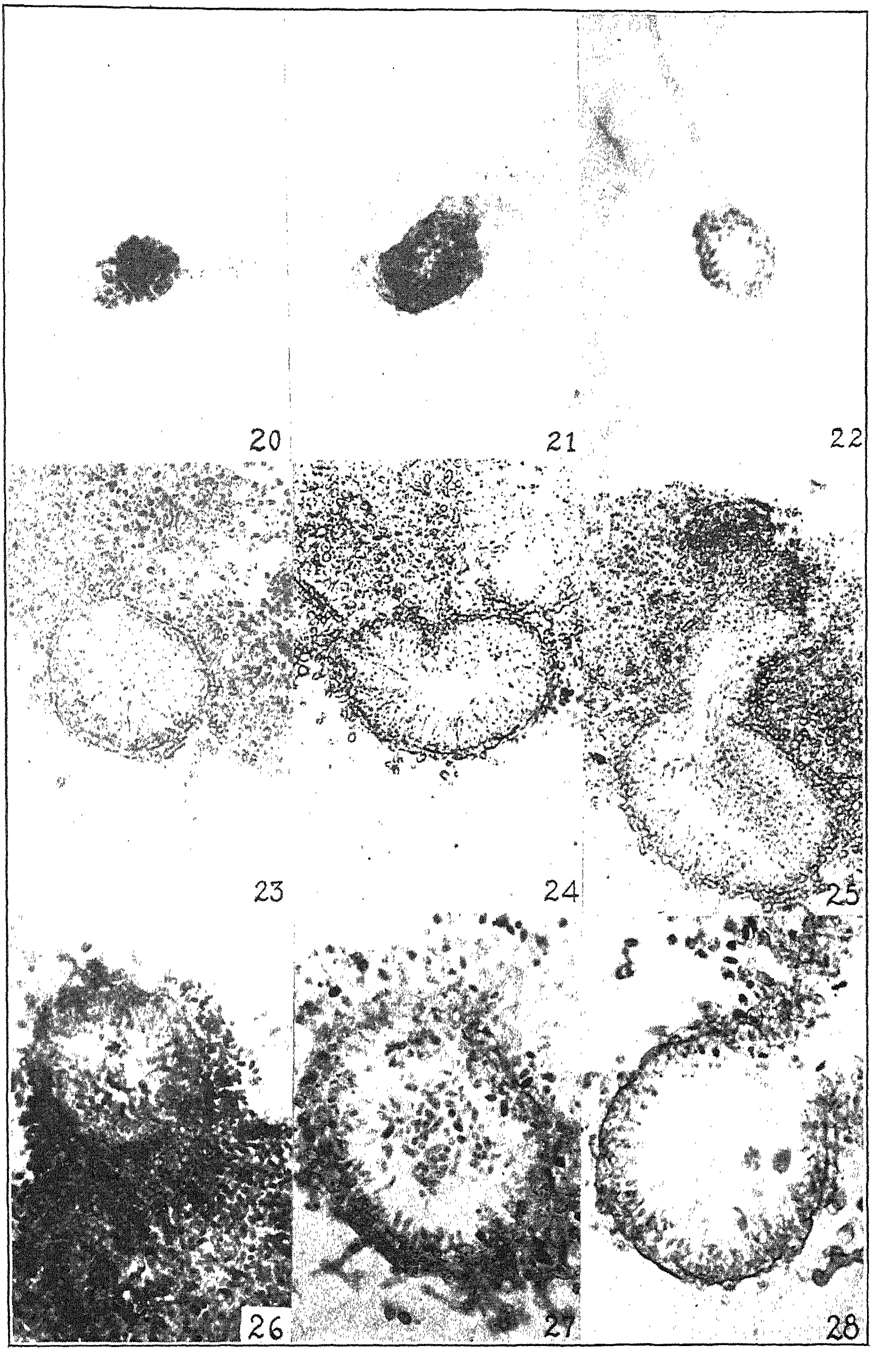
Fig. 28. Mature pycnidium from which spores have escaped. ×700.



BENHAM: PHOMA CONIDIOGENA



BENHAM: PHOMA CONIDIOGENA



BENHAM: PHOMA CONIDIOGENA

Studies on the Flora of Northern South America—XV. Recent collections of Melastomataceae from Peru and Amazonian Brazil

H. A. Gleason

Mr. E. P. Killip, of the Smithsonian Institution, and Mr. A. C. Smith, of the New York Botanical Garden, landed at Callao, Peru, in April, 1929, travelled overland and by boat across the Andes to Iquitos, and thence by steamer down the Amazon to Pará, collecting in the departments of Ayacucho, Junín, and Loreto, Peru, and in the vicinity of Manáos and Pará, Brazil. Mr. Llewellyn Williams, of the Field Museum, reversed this route, collecting at Pará and extensively in Dept. Loreto, entering the Andes in Dept. San Martín, and collecting in the vicinity of Tarapoto. Mr. G. Klug, of Iquitos, has more recently made considerable collections in the vicinity of Iquitos. A few other collectors have also supplied smaller quantities of material.

These collections have been of particular interest, since the localities are essentially the same as those of Poeppig, Spruce, Ule, and Tessmann, whose material has furnished the types for numerous species and is generally poorly represented in American herbaria. The arrangement below follows the well known taxonomic sequence of Cogniaux' Monograph, and the principal collectors are cited merely by their initials, *KS*, *W*, and *K*. All collections cited are in the herbarium of the New York Botanical Garden, unless definitely stated otherwise.

Microlicia Don

Microlicia sphagnicola sp. nov. §*Pseudomicrolicia;* ramis dichotomis, juventute tetragonis dense glandulosis ad nodos setosis, mox denudatis subtetragonis setis persistentibus; foliis ad summum ramorum confertis internodis brevibus, coriaceis sessilibus revolutis ellipticis 3-nerviis utrinque punctatis; floribus paucis terminalibus 4-meris, pedicellis brevibus glandulosis; hypanthio obconico 8-costato glanduloso superne 4-setoso; sepalis ovato-lanceolatis ad mediam marginemque glandulosis aristatis; petalis rotundato-obovatis margine glandulosis; staminum exteriorum majorum connectivo infra insertionem filamentae longe producto truncato, interiorum breviter producto obtuso; ovario 3-loculare, stigmate punctiforme.

Shrubby, about a meter high, freely dichotomously branched; young stems sharply 4-angled with concave sides, densely glandular with short stout hairs, with about 4 very slender erect setae between each pair of leaf-bases on each side; internodes 1 mm. long; older stems leafless, with persistent setae; leaves rigid, coriaceous, sessile, narrowly elliptic, 5–7 mm. long, 2 mm. wide, acute at both ends, with revolute margin 0.2 mm. wide, 3-nerved with an

obscure marginal pair, densely pulverulent on both sides with cylindrical bodies 0.3 mm. high; secondaries obscure and crooked; flowers few, 4-merous, solitary in the uppermost axils, apparently terminal but becoming lateral by proliferation of the main axis; pedicels obscurely 4-angled, 1.3 mm. long, glandular like the stem; hypanthium obconic, 3.4 mm. long, with 8 low rounded ribs, densely glandular-punctate, bearing an erect purple seta 2 mm. long at each sinus; calyx-tube prolonged 0.5 mm., to rounded sinuses; sepals ovate-lanceolate, 2 mm. long, acute, sparsely glandular along the thickened center and densely glandular on the margin, ending in an awn 0.7 mm. long; petals pink, broadly rotund-obovate, 6–7 mm. long and wide, flabellately veined above a 7-nerved base, finely glandular on the margin; filaments nearly straight, 3.4–3.7 mm. long, glabrous, slightly flattened; anthers of episepalous stamens oblong, 2.2–2.4 mm. long, including the stout straight beak 0.6 mm. long, the connective prolonged 2.8 mm. below the anther and gradually widened to the insertion of the filament, below the filament prolonged 1.7 mm. into a thick, flattened, obovate, truncate, obscurely 5-lobed organ 1 mm. wide; anthers of the epipetalous stamens 1.9 mm. long, including the beak 0.3–0.4 mm. long, the connective prolonged 1.8 mm. to the filament, gradually thickened but not flattened, below the filament prolonged 0.6 mm. in an obtuse ovoid-oblong lobe; ovary free, oblong-ovoid, 2 mm. long, 3-celled, obscurely 8-ribbed and 4-lobed at the summit; style 4 mm. long, slender, terete, glabrous, with a punctiform stigma.

Type, *KS 25680*, collected in an open sphagnum swamp at Eneñas, on the Pichis Trail, Dept. Junín, Peru, alt. 1700 m.; the species was noted as a characteristic plant of this swamp. It is related to *M. Weddellii* Naud., also of Peru, and differs from it in its entire leaves and shorter and broader sepals.

RHYNCHANTHERA DC.

RHYNCHANTHERA HOOKERI Naud. Dept. San Martín, San Roque; *W 7283*.

Rhychanthera Williamsi sp. nov. Ramis obscure 4-angulatis brevissime glanduloso-hirtellis; petiolis brevibus crassis dense glandulosis et hirsutis; foliorum laminis anguste ovatis acuminatis basi subcordatis serrulatis 7-nerviis, supra sparse pilosis praecipue secus venas, subtus ad venas venulasque pubescentibus; cymis confertifloris bracteosis, pedicellis brevissimis; hypanthio tubuloso ad faucem ampliato dense glanduloso-hirtello; sepalis erectis triangulari-lanceolatis quam hypanthio paullum brevioribus; petalis late rotundatis ad apicem aristatis; staminibus sterilibus filiformibus ad apice recurvatis; staminum fertilium filamentis crassis; antheris lanceolato-ovoideis longe rostratis; connectivo basi breviter producto ad insertionem filamenti minute tuberculato; ovario subcylindrico superne glanduloso-pubescente; stylo gracile usque mediam glanduloso-puberulente; stigmate punctiforme.

Stems subherbaceous, apparently erect, glandular-hirtellous with hairs 0.3 mm. long and very sparsely hirsute with simple hairs 1.5 mm. long; petioles stout, 6–10 mm. long, very densely glandular-hirtellous and freely hirsute, increasingly so above; blades firm, narrowly ovate, as much as 5 by 3 cm., acuminate, finely serrulate with glandular-setose teeth, subcordate at base, 7-nerved or barely 9-nerved, sparsely pubescent above, chiefly near the primaries, with incurved hairs 0.4 mm. long, much more freely pubescent with similar hairs beneath, especially on the veins; cymes small and crowded, subtended by lanceolate bracts; pedicels about 1 mm. long; hypanthium tubular, somewhat expanded at the throat, 4.5 mm. long, glandular-punctate and densely glandular-hirsute with hairs 0.4–0.5 mm. long; calyx-tube prolonged 0.2 mm.; sepals erect, triangular-subulate, 3.4 mm. long, minutely aristate, pubescent externally like the hypanthium; petals rotund, 5 mm. long and wide, with a subulate acumen 0.4 mm. long; sterile stamens filiform, 3.3 mm. long, hooked at the end; filaments stout and thick; anthers lanceolate-ovoid, 3.6 mm. long, the slender beak 4.7 mm. long; connective stout, prolonged 1 mm. to the filament and at base minutely tuberculate on the anterior side; ovary subcylindric, 3-celled, densely glandular in the upper half; style slender, 6.5 mm. long, glandular-pubescent on the lower half; stigma punctiform.

Type, *W* 7284, collected at San Roque, Dept. San Martín, Peru, alt. 1350–1500 m. It is a member of § *Isostemones* and obviously related to *R. Hookeri* Naud., which has a hispid stem, shorter and spreading sepals, longer and narrower petals attenuate at the base, shorter anther-beak, a slender and more elongate connective 2-toothed at the base, ovoid ovary, and much longer style.

Arthrostemma R. & P.

Arthrostemma grandiflorum Markg. Dept. Ayacucho: *KS 23082, 23114;* Dept. Junín: *KS 23572, 23932, 25225, 26618;* Dept. Loreto: *KS 29160.* There is no doubt that these seven specimens may be properly referred to this species, but there is some doubt whether the species can be maintained after thorough study of the genus. Markgraf certainly had little material available for comparison when he proposed it, the Berlin herbarium containing in 1930 only seven sheets from South America, in comparison with seventeen at Kew and thirty at New York.

Ernestia DC.

Ernestia quadrisetosa Berg. Dept. San Martín, Tarapoto (type locality): *W 5989;* Dept. Loreto, Balsapuerto: *KS 28600.*

Nepsera Naud.

Nepsera aquatica (Aubl.) Naud. Manáos: *KS 30054;* at or near Pará: *KS 30308, 30409; Dahlgren & Sella 315.*

DESMOCELIS Naud.

DESMOCELIS VILLOSA (Aubl.) Naud. Dept. San Martín, San Roque: *W 7118, 7410.*

BRACHYOTUM Triana

BRACHYOTUM LYCOPODIOIDES Triana. Dept. Amazonas: *W 7587.*

BRACHYOTUM QUINQUENERVE (R. & P.) Triana. Dept. Ayacucho: *KS 22272, 22333;* Dept. Junín: *KS 24131, 24448.*

BRACHYOTUM TRIANAEI Cogn. Dept. Amazonas, Chachapoyas: *W 7572.*

PTEROGASTRA Naud.

PTEROGASTRA DIVARICATA (Bonpl.) Naud. Dept. San Martín, San Roque: *W 7116, 7643.*

PTEROLEPIS Miq.

PTEROLEPIS PUMILA (Bonpl.) Naud. Near Pará: *KS 30416.*

PTEROLEPIS TRICHOTOMA (Rottb.) Naud. Near Pará: *KS 30490, Dahlgren & Sella 319, 346.*

TIBOUCHINA Aubl.

TIBOUCHINA ASPERA Aubl. Dept. San Martín: *Williams 7648.*

Tibouchina decora sp. nov. § *Diotanthera;* fruticosa, ramis dense et breviter strigosis; foliis mediocris ovato-oblongis acutis integris basi rotundatis 5-nerviis supra dense velutino-strigosis subtus dense et molliter villosis ad venas strigosis; cymis satis multifloris strigosis, bracteis anguste lanceolatis; floribus 5-meris; hypanthio anguste campanulato dense strigoso quam pedicello longiore; sepalis quam hypanthio paullum brevioribus triangulari-lanceolatis strigosis ciliatis; filamentis glabris; antheris paullum inaequalibus connectivo basi breviter producto antice bilobato; ovario 5-loculare superne strigoso, stylo elongato glabro.

Stems shrubby, rather sparsely branched, densely strigose with pale brown incurved hairs about 0.5 mm. long, from subulate or papillose bases; petioles 7–11 mm. long, pubescent like the stem; blades rather thick, ovate-oblong, 35–55 mm. long, 18–25 mm. wide, acute, entire or rarely minutely serrulate, rounded at base, 5-nerved, the outermost laterals arising just above the base of the intermediate pair; secondaries obscure above, very numerous, ascending arcuately at an angle of about 60°; upper surface densely velutinous with curved-ascending hairs 0.5 mm. long and about 0.2 mm. apart; lower surface gray and densely sericeo-villous, especially on the secondaries, and strigose on the primaries with closely appressed hairs 1 mm. long; inflorescence compact and many-flowered, densely sericeous, bracts linear-lanceolate, about 1 cm. long; hypanthium longer than the pedicel, tubular-campanulate, 7 mm. long, densely strigose or subsericeous with incurved hairs 1–1.5 mm. long and

with a spreading or ascending seta at each sinus; calyx-tube prolonged 0.8 mm. to sharp acute sinuses; sepals triangular-lanceolate, 5.5 mm. long, strigose down the midvein, densely ciliate, crimson within; petals magenta, broadly triangular-obovate, 12 mm. long, 8.5 mm. wide, obliquely truncate, freely ciliate; filaments glabrous, 7 or 9 mm. long; anthers subulate, nearly straight, 7 or 9 mm. long; connective 1 or 1.5 mm. long, incurved, deeply canaliculate ventrally and dilated at base into 2 short rounded anterior lobes; ovary 5-celled, ovoid-fusiform, 4.8 mm. long, glabrous below, densely strigose in the distal fourth; style slender, curved above, glabrous, about 15 mm. long; stigma punctiform.

Type, *KS 22700*, a shrub 3–7 ft. high, in thickets at Aina, between Huanta and Río Apurimac, Dept. Ayacucho, Peru, alt. 750–1000 m. Other specimens are *KS 24230*, *24791*, and *24979*, from Dept. Junín at altitudes between 680 and 2400 m. This species is probably the same as a collection of Pearce at Kew, labeled *T. panicularis* (Naud.) Britton, but obviously not of that species, which has 7-pli-nerved leaves and a much coarser pubescence. In the form and pubescence of its leaves it closely resembles *Rusby 2327* from Yungas, Bolivia, and differs chiefly in its much larger flowers. Rusby's plant has been erroneously identified as *T. panicularis*. *T. decora* is probably more closely related to *T. Brittoniana* Cogn., also from Yungas, but differs in many characters of size, form, and pubescence.

Tibuochina laxa (Desr.) Cogn. Dept. Amazonas, Chachapoyas: *W 7573*.

Tibouchina longifolia (Vahl) Baill. Dept. Ayacucho: *KS 22499*, *23075*; Dept. San Martín: *W 6364*, *7151*; Dept. Junín: *KS 23567*, *23789*, *24968*, *25197*, *25278*; Dept. Loreto: *KS 27848*, *29216*.

Tibouchina ochypetala (R. & P.) Baill. Puyash: *Sawada 95*; Dept. San Martín: *W 5953*, *6385*, *6492*.

Tibouchina Tessmanii Markg. Dept. Loreto: *KS 28618*, *29210*.

Comolia DC.

Comolia veronicaefolia Benth. Near Pará: *KS 30617*.

Aciotis Don

Aciotis brachybotrya (DC.) Triana. Dept. Junín, Pichis Trail: *KS 25892*.

Aciotis dysophylla (Benth.) Triana. Dept. Loreto: *KS 26888*, *29852*, *W 1447*, *1486*, *1710*, *1712*, *K 1188*; Manáos: *KS 30088*; Pará: *KS 30367*.

Aciotis indecora (Bonpl.) Triana. Dept. Loreto, Manfinfa on the upper Río Nanay: *W 1179*, *1180*.

ACIOTIS PURPURASCENS (Aubl.) Triana. Dept. Junín: *KS 26229;* Dept. Loreto: *KS 26958, 28173, 28206, K 144, 1489, W 463, 803, 883, 1185, 1276, 1474, 1485, 1930, 2568, 2701, 3209, 3813, 4739, 7848;* Manáos: *KS 30055.*

MONOCHAETUM Naud.

Monochaetum subglabrum sp. nov. Grex *Dicranantherae;* frutex ramosus metralis, ramis parce pilosis; petiolis gracilibus strigosis; laminis ovatis acutis basi late cuneatis, 5-pli-nerviis, supra inter venas parce pilosis, subtus ad nervos strigosis ceterum parce pilosis; inflorescentia ramosa multiflora subglabra; hypanthio tubuloso-campanulato inferne glabro superne parce piloso; sepalis triangulari-lanceolatis quam hypanthio paullum longioribus acutis glabris ciliatis; petalis obovatis; antheris minoribus rectis appendice oblanceolata, majoribus arcuatis appendice arcuata sursum dilatata; ovario summo corona pilorum ornato.

Stems shrubby, 6–15 dm. high, freely branched, very sparsely pilose with simple hairs about 1 mm. long and 2–3 mm. apart; petioles slender, 1–2 cm. long, sparsely strigose; leaf-blades thin, ovate, as much as 45 by 28 mm., rounded below to a short cuneate base, acute or subacuminate, 5-pli-nerved, the upper surface sparsely pilose between the veins, the hairs 1–1.5 mm. long and not overlapping, the lower surface very sparsely pilose, more densely strigose on the veins where the hairs are 1–1.3 mm. long and overlapping; upper leaves much reduced, proportionately narrower, and acuminate; inflorescence freely branched, many-flowered, the smaller branches essentially glabrous; hypanthium tubular-campanulate, 4 mm. long, glabrous below, sparsely pilose around the summit with simple hairs 0.5–1 mm. long; sepals triangular-lanceolate, 4.5 mm. long, 1.6 mm. wide at base, sharply acute, glabrous on both sides, finely ciliate and short-setose at the tip; petals white or pink, obovate, 6–7 mm. long, glabrous; filaments 6 or 8 mm. long; small anthers straight, 4.3 mm. long, the appendage oblanceolate, obtuse, flat, 3.5 mm. long; large anthers strongly arcuate, 6 mm. long, the arcuate appendage 4 mm. long, dilated toward the summit, somewhat channeled on the concave side; ovary free, ovoid, glabrous, except at the summit, where it bears 12–16 erect hairs 0.7 mm. long; style 4 mm. long; stigma punctiform.

Type *KS 22325*, collected at Ccarrapa, Dept. Ayacucho, Peru, alt. 1500 m.; other specimens by the same collectors are *22299*, from the same locality, alt. 2500 m., and *24423*, from Carpapata, Dept. Junín, alt. 2700–3200 m. The species is closely related to *M. dicranantherum* (R. & P.) Naud., which has much denser spreading pubescence on the stem, leaves, and hypanthium and shorter and much broader sepals.

ADELOBOTRYS DC.

Adelobotrys macrantha sp. nov. Ramis crassis obtuse 4-angulatis et sulcatis brunneo-strigosis mox glabrescentibus; petiolis amplis crassis; foliorum

laminis magnis ellipticis utrinque acutis 5-nerviis supra primum sparsissime strigosis mox glabris subtus tenuiter strigosis; paniculis magnis dense strigosis; pedicellis hypanthio brevioribus in eum gradatim dilatatis; hypanthio magno obconico strigoso; calycis limbo patulo, sepalis brevibus late rotundatis, dentibus exterioribus minutis; petalis magnis; staminibus fere isomorphis, calcare basale series exterioris incurvo series interioris erecto, calcare dorsale canaliculato breviter bifido; ovario 4-loculare; stylo terete, stigmate truncato.

Branches stout, roundly 4-angled and deeply sulcate when young, the uppermost internodes densely brown-strigose with short hairs, the lower glabrous; petioles stout, 3–5 cm. long, closely but completely pubescent; blades thin, elliptic, as much as 14 by 25 cm., even on the uppermost nodes, abruptly acuminate, densely brown-ciliate, broadly acute at base, 5-nerved; primaries lightly impressed above, elevated and prominently strigose beneath, secondaries plane above, lightly elevated beneath, 5–7 mm. apart, arising at an angle of 70–80° and somewhat outwardly arcuate, minutely strigose beneath; upper surface very sparsely strigose when young, soon glabrescent; lower surface thinly strigose with brown hairs; panicles ample, densely strigose, 15–25 cm. long, the umbels mostly 5–7-flowered; pedicels about 5 mm. long, gradually expanded into the hypanthium; hypanthium obconic, leathery, 9 mm. long to the torus, freely brown-strigose; calyx-tube flaring, prolonged about 3 mm., nearly glabrous; sepals depressed semicircular, about 0.7 mm. long, very minutely ciliate, the external teeth minute conic adnate thickenings; petals pink, cuneately and obliquely obovate, about 19 mm. long and 10 mm. wide, flabellately veined; filaments flat, 12–13 mm. long; anthers nearly straight, the epipetalous 13.5, the episepalous 8.5–9 mm. long; dorsal spur nearly straight, 4–5 mm. long, channeled on the lower side, bifid, the lobes subulate, connivent, 0.8 mm. long; basal spur 2–3 mm. long, erect in the epipetalous, incurved in the episepalous stamens; ovary stoutly ellipsoid or somewhat obovoid, 4-celled; style slender, 16 mm. long, not tapering, stigma truncate; fruiting hypanthium and calyx about 15 mm. long, the seeds very slenderly clavate, 2 mm. long, with the embryo near the center.

Type, *KS 26745*, collected at Cahaupanas, on the Río Pichis, Dept. Junín, Peru, alt. about 340 m. It is described as a shrub 15–20 ft. tall, growing in dense forest, with rich pink petals and yellow anthers. A second specimen is *KS 29496*, from San Antonio on the Río Itaya, Dept. Loreto, alt. about 110 m., in fruit, described as a slender tree 10–12 ft. high; a sterile specimen, *KS 29616*, from Soledad on the Río Itaya, described as a subligneous vine, has also been referred here because of similarity in foliage and pubescence. The species is well distinguished from other known species of the genus by its large leaves and flowers, its minute exterior calyx-teeth, its nearly isomorphic anthers, and the short lobes of the dorsal spur.

The same species was previously collected by Tessmann, no. *4181*, and

distributed as *A. fuscescens* Triana, which has much smaller flowers with long exterior calyx-teeth.

ADELOBOTRYS MACROPHYLLA Pilger. Dept. Loreto, La Victoria: *W 2914, 2915.*

ADELOBOTRYS PRAETEXTA Pilger. Dept. Loreto, Santa Ana on the upper Río Nanay: *W 1231.*

Adelobotrys subsessilis, sp. nov. Ramis gracilibus juventute strigosis mox glabrescentibus; foliis brevissime petiolatis anguste oblongo-lanceolatis acutis basi rotundatis integris 3-nerviis, supra juventute sparse strigosis glabrescentibus, subtus ad venas dense inter venas sparse brunneo-strigosis; paniculis racemiformibus dense strigosis, ramis lateralibus ad apicem umbellam 5-floram gerentibus; floribus pedicellatis; hypanthio obconico dense strigoso; sepalis late oblongis membranaceis ciliatis, dentibus exterioribus patulis crasse conicis strigosis; staminibus subisomorphis; antheris subulatis arcuatis dorso calcare simplice ornatis, connectivo basi in calcar breve erectum conicum producto.

Stem subterete, loosely strigose above with malpighian hairs, the ascending arm 1–1.5 mm., the descending 0.8 mm. long, all deciduous with age and increasing distally to the inflorescence; internodes 3–5 cm. long; petioles about 2 mm. long, densely hirsute with similar but spreading hairs; blades membranous, lance-oblong, 5–7 cm. long, 1.5–2 cm. wide, subacuminate, rounded at base, entire, 3-nerved with 2 additional submarginals, the secondaries and tertiaries obsolete, upper surface minutely but densely verruculose and evanescently strigose, lower surface densely brown-strigose with malpighian hairs on the primaries and thinly so in 2 intervenal and 2 marginal strips; panicle compact, 10 cm. long, the short lateral branches bearing 5-flowered umbels, densely strigose throughout; pedicels about 5 mm. long, densely strigose; hypanthium obconic, 5.6 mm. long to the torus, 10-ribbed, minutely glandular-punctate, freely brown-strigose; calyx-tube flaring, rather thick, 1 mm. long, elevated at the center of each sepal into spreading, stoutly conic exterior teeth 0.8 mm. long and densely strigose; sepals membranous, depressed-oblong, 0.5–0.6 mm. long by 2 mm. wide, minutely ciliate; petals pink, broadly obovate, 9 mm. long, 5 mm. wide, somewhat inequilateral, retuse, flabellately many-nerved; filaments straight, erect, flat, 7.5 mm. long; anthers subulate, the episepalous slightly arcuate, 6 mm. long, the dorsal spur stout, oblong, nearly terete, 2.4 mm. long, the connective prolonged below the filament into an erect, stoutly conic, obscurely bilobed spur 1.5 mm. long, the epipetalous anthers similar, strongly arcuate, 7 mm. long, the dorsal spur slender, 2.6 mm. long, the basal spur 1.3 mm. long, not lobed; ovary free, 5-celled, minutely 5-lobed below the rounded summit; style slender, 9 mm. long, bent laterally just below the summit; stigma punctiform.

Type, *KS 27147*, collected at Iquitos, Dept. Loreto, Peru, alt. about 100 m.; it is described as a slender shrub 10–12 ft. high. Its narrow, sub-

sessile leaves with longitudinal strips of deep brown hairs and its racemiform panicles give it an aspect different from any other species in the genus.

ADELOBOTRYS TESSMANNII Markg. Terr. Caquetá, Colombia: *Woronow & Juzepczuk 6375.*

ADELOBOTRYS sp. Dept. Loreto, Balsapuerto: *KS 28501.* Although described as having pink petals and yellow anthers, our specimens do not show flowers. The plants impress me as shade forms of some other species and will not be described as new.

ADELOBOTRYS sp. Dept. San Martín, San Roque: *W 7108*, a fruiting plant.

MERIANIA Sw.

Meriania intonsa sp. nov. §*Adelbertia:* ramis scandentibus hirsutis, internodis elongatis; petiolis brevibus crassis dense hirsutis; foliorum laminis ellipticis mediocribus abrupte acuminatis tenuiter serrulatis basi subcordatis 5-nerviis, supra dense longeque pilosis, subtus ad venas hirsutis ad paginam breviter pilosis; inflorescentia terminale sessile pauciflora capitata, bracteis sessilibus cordato-ovatis hirsutis circumdata; floribus 5-meris subsessilibus; hypanthio anguste obconico 10-costato sparse strigoso-hirsuto; calycis limbo margine undulato; dentibus exterioribus longissimis hirsutis aristatis; petalis parvis obovatis; staminibus isomorphis; antheris subulatis paullum arcuatis poro unico dehiscentibus; connectivo deorsum in calcar breve conicum et sursum in calcar dimidio antheris aequante producto; ovario 5-loculare.

Stems climbing, slender, irregularly hirsute with crooked brown hairs 1–2 mm. long, becoming glabrous below, the internodes 4–8 cm. long; petioles stout, 6–13 mm. long, densely hirsute; leaf-blades thin and soft, elliptic or ovate-elliptic, as much as 85 by 55 mm., abruptly short-acuminate, subcordate at base, shallowly serrulate, at least below the middle, 5-nerved; upper surface pilose with yellowish hairs about 3 mm. long and 1 mm. apart, the secondaries obsolete; lower surface sparsely pilose with slender hairs 1–1.7 mm. long and 1–1.5 mm. apart, the primaries strigose-hirsute with brown hairs 3 mm. long, the secondaries obscure, about 5 mm. apart; inflorescence terminal, sessile, capitate, several-flowered, 1–2 cm. long, subtended by several sessile, cordate-ovate, acute, hirsute bracts 5–8 mm. long; pedicels 1–2 mm. long, sparsely hirsute; flowers 5-merous; hypanthium narrowly obconic, 4.2 mm. long, 10-costate, sparsely strigose-hirsute with brownish hairs 0.5–1 mm. long; calyx-tube spreading, 1 mm. wide; sepals thin and membranous, round-ovate, rounded at the tip, 0.3–0.6 mm. long; exterior teeth subulate, curved outward and upward, 3.6 mm. long, hirsute, tipped with a straight awn 4.8 mm. long; petals (not fully expanded) obovate, 5 mm. long, 4 mm. wide, broadly rounded above, freely nerved; stamens isomorphic; filaments (not fully expanded) flattened, 2 mm. long; anthers subulate, somewhat outwardly arcuate, 3 or 5.6 mm. long, opening by a single pore; connective 2-spurred at base, the

basal spur conic, 0.7 mm. long, the dorsal linear, 2–2.2 mm. long, minutely 2-lobed at the apex, closely appressed to the anther; ovary slender, free, glabrous, 5-celled; style 4 mm. long; stigma capitate.

Type *KS 29969*, collected at Mishuyacu, near Iquitos, Dept. Loreto, Peru; other specimens from the same locality are *K 90* and *1334*. The elongated exterior teeth of the calyx and the sessile inflorescence show that it is related to *M. prunifolia* D. Don, which lacks the long pubescence of the stem, leaves, and hypanthium, has much smaller obtuse leaves, and solitary flowers. The color of the petals is described on the three sheets as white, lilac, and cream. The width of the leaves varies considerably, being least in *1334*, where it is often less than half of the length, and broadest in *90*, where it may be as much as three-fourths of the length. The single flower-cluster in *90* seems to be lateral, but probably is terminal on a short concealed branch.

MERIANIA SPRUCEANA Cogn. Dept. San Martín, San Roque: *W 7010.*

GRAFFENRIEDA DC.

GRAFFENRIEDA LIMBATA Triana. Dept. Junín, Colonia Perene: *KS 24953;* Dept. San Martín, Tarapoto (type locality): *W 5893.*

GRAFFENRIEDA PATENS Triana. Dept. Loreto, near Iquitos: *K 413.*

GRAFFENRIEDA STENOPETALA Ule. This name has been applied to a well-marked species from Mount Roraima, resembling *G. intermedia* Triana in general habit but differentiated by its long, triangular, sharply acute sepals. Like that species, its flowers are 4-merous. *KS 24950* can not be distinguished from its specifically, differing only in some very small matters of dimensions, but has 5-merous flowers. This does not affect the validity of the species, but may throw some doubt on the value of the number of flower-parts in the classification of species in this genus. In comparison with the type, the recent collection has somewhat looser flower-clusters and less pubescent infloresence.

CALYPTRELLA Naud.

CALYPTRELLA CUCULLATA (Don) Triana. Dept. San Martín: *W 6459, 7109.*

CALYPTRELLA TRISTIS Triana. Dept. San Martín, Tarapoto (type locality): *W 5987.*

SALPINGA Mart.

SALPINGA SECUNDA Schr. & Mart. Dept. Loreto: *KS 27148, 27328, 27388, 29667, 29921, K 517.*

MONOLENA Triana

MONOLENA PRIMULAEFLORA Hook.f. Dept. Junín, Pichis Trail: *KS 26131, 26205.*

DIOLENA Naud.

DIOLENA AMAZONICA Pilger. Dept. Junín: *KS 25385, 26660, 26800;* Dept. Loreto: *KS 29502, 29568, W 1804, 3421.* This recently described species seem to be common in Amazonian Peru and we have it from altitudes up to 700 m.

LEANDRA Raddi

LEANDRA CHAETODON (DC.) Cogn. Dept. Junín, Pichis Trail: *KS 26211;* Dept. Loreto: *KS 26928, 26971, 28336, W 1328, 2687, 3762.*

LEANDRA DICHOTOMA (Don) Cogn. Dept. Junín: *KS 2367, 24803, 25301, 26081;* Dept. San Martín: *W 7186.*

LEANDRA FRANCAVILLANA Cogn. Dept. Junín: *KS 26223, 26557;* Dept. Loreto, *KS 27303, 28593, W 2555, 2686, 8238.* The first specimen cited is pubescent with red-purple hairs which give it a somewhat different aspect.

LEANDRA LONGICOMA Cogn. Dept. Loreto: *KS 27087, 27242, 28252, 28415, 28558, 29233, 29453, 29583, W 631, 704, 1693, 2327, 7838, K 1150.*

LEANDRA NERVOSA (Naud.) Cogn. Dept. Ayacucho, Ccarrapa: *KS 22370.*

LEANDRA RETROPILA Cogn. Dept. Ayacucho, Estrella: *KS 22672;* Dept. Junín, Pichis Trail: *KS 26134.*

LEANDRA REVERSA (DC.) Cogn. Dept. Junín, above San Ramón: *KS 24736.*

LEANDRA RUFESCENS (DC.) Cogn. Pará: *KS 30351, Dahlgren & Sella 484.*

LEANDRA SECUNDA (Don) Cogn. Dept. Loreto: *KS 27349, 28334, 28464, 28774, W 788, 797, 1260, 1291, 1670, 2080, 2207; K 1262.*

LEANDRA SOLENIFERA (Schr.) Cogn. Dept. Loreto, Pebas: *W 1905.*

PTEROCLADON Hook. f.

PTEROCLADON SPRUCEI Hook. f. Dept. San Martín, San Roque: *W 7050;* Dept. Junín, Pichis Trail: *KS 26102,* a teratological form with abortive flowers.

MICONIA R. & P.

§I. *Jucunda*

MICONIA HOLOSERICEA (L.) Triana. Dept. San Martín, Lamas: *W 6435;* Dept. Junín, San Ramón: *KS 24766, 24800.*

§II. *Tamonea*

MICONIA ACUMINIFERA Triana. Dept. Junín: *KS 24000, 25575, 25997, 26188;* Dept. San Martín: *W 7421*. Our specimens are conspecific with *Triana 3997* from Colombia, apparently the type of the species.

MICONIA AMAZONICA Triana. Dept. San Martín, Tarapoto: *W 6076;* Dept. Loreto: *KS 29193, W 4588.*

MICONIA AUREA (Don) Naud. Dept. Loreto: *W 7858.*

MICONIA BUBALINA (Don) Naud. Dept. Loreto: *KS 26924, 27216, 29856, W 3666, 3707.*

MICONIA DODECANDRA (Desr.) Cogn. Dept. Junín, near La Merced: *KS 23920.*

MICONIA DONAEANA Naud. Dept. San Martín, San Roque: *W 7002, 7055.*

Miconia flaccida sp. nov. §*Tamonea;* ramis acute 4-angulatis et anguste 4-alatis, ad nodos tenuiter furfuraceis ceterum glabris; foliis anguste ellipticis acuminatis integris ad petiolum gracilem longe cuneatis glabris 3-pli-nerviis; panicula ramosa axibus 4-alatis ad nodos tenuissime furfuracea; floribus sessilibus 5-meris; hypanthio anguste campanulato furfuraceo; sepalis late triangularibus acutis e sinubus rotundatis; petalis obovato-oblongis inaequaliter retusis extus furfuraceis; staminibus circa 15 isomorphis; filamentis glabris; antheris crasse subulatis connectivo non producto; ovario 5-loculare; stylo longe exserto stigmate capitato.

Shrub 2–3 m. high, the branches sharply 4-angled and narrowly winged, somewhat swollen and thinly furfuraceous at the nodes, otherwise glabrous; petioles slender, 2–3 cm. long, glabrous; blades thin, pale green, narrowly elliptic, 25–35 cm. long, 6–7 cm. wide, long-acuminate, entire, long-cuneate at base, glabrous throughout, 3-pli-nerved; primaries plane above, barely elevated beneath, the lateral about 3 mm. from the margin; secondaries plane on both sides, 8–12 mm. apart, ascending at an angle of about 75°; tertiaries obscure, reticulate; panicle 15 cm. long, widely branched, the axes sharply 4-angled, narrowly 4-winged, thinly furfuraceous at the nodes; flowers in terminal clusters of 3, the central sessile, the lateral sessile or very short-pedicelled, 5-merous; hypanthium tubular-campanulate, 2.7 mm. long to the torus, very minutely and sparsely pulverulent; calyx-tube erect, prolonged 0.8 mm.; sepals broadly triangular from rounded sinuses, 0.4 mm. long, acute, the exterior teeth reduced to minute subapical thickenings, pulverulent like the hypanthium; petals obovate-oblong, 4 mm. long, 2.3 mm. wide, strongly inequilateral and conspicuously retuse, minutely but densely furfuraceous externally; stamens variable in number, about 15, isomorphic; filaments 4 mm. long, slightly flattened, glabrous; anthers stoutly subulate, nearly straight, 3 mm. long, the slender connective neither appendaged nor prolonged; ovary

half-inferior, 5-celled, its rounded summit glabrous; style straight, glabrous, slender, 7 mm. long; stigma capitate, 1.2 mm. in diameter.

Type, *KS 25625*, collected in dense forest on the Pichis Trail, Dept. Junín, Peru, alt. 1600–1900 m. The species is remarkable in several ways: its square winged stems are hollow, and in one place have been punctured at a swollen node by some insect, suggesting a possible myrmecophily; the general aspect of its inflorescence is unusual, its numerous stamens resemble those of §*Tamonea* more closely than any other section of the genus, but suggest those of *Tococa*. There is no species known to me with which it may well be compared or to which it seems to be related; under the arrangement of species in Cogniaux' Monograph it should find a place near *M. reducens* Triana.

MICONIA GLANDULIFERA Cogn. Dept. Junín, Pichis Trail: *KS 25451*, near Perene Bridge: *KS 25373;* Dept. Loreto: *KS 28153*, *W 4100.*

MICONIA MACROPHYLLA (Don) Triana. Dept. Junín, near Perene Bridge: *KS 25297;* Dept. San Martín, San Roque: *W 7793;* in the lowlands of Dept Loreto: *KS 27094, 27507, 28561, 29157, 29531, W 1481, 1646, 1996, 2770, 4569.*

MICONIA PARVIFLORA (Benth.) Cogn. Dept. Loreto: *W 901;* Manáos: *KS 30010, 30142.*

MICONIA TRAILLII Cogn. *W 1629* and *1631*, from Dept. Loreto, are fruiting specimens in which the form of the hypanthium strongly indicates the section *Tamonea*. They have been compared with Traill's type of the species at Kew, which they resemble considerably in foliage, and are referred here tentatively.

§III. *Adenodesma*

MICONIA AMPLEXANS (Crueg.) Cogn. *Pogonorhynchus amplexans* Crueg. (1847; Trinidad), *Miconia umbrifera* Naud. (1851; Peru), *Miconia symplectocaulos* Pilger (1905; Amazonas). The early descriptions given by Crueger and Naudin are so clear that there is no doubt of their application, but it has been necessary to decide whether the Ule plant upon which Pilger based his species differs specifically. Existing material of the type of *P. amplexans* is apparently to be found only at Kew and is not in good condition. Nevertheless, careful examination has convinced me that it is conspecific with the plants from Loreto and Amazonas, as well as with others from farther south in Bolivia. The Berlin herbarium contains five different collections of Tessmann and Ule which have been referred to *M. symplectocaulos*, and all of them would have been placed in *M. amplexans* by anyone using Cogniaux' Monograph as a guide. The same herbarium contains but

a single specimen under *M. amplexans*, *Poeppig 1424*, which is actually *M. amplexicaulis* Naud. One can imagine that Pilger, consulting the herbarium to confirm his identification of Ule's plant and finding this sheet only, saw at once that he was dealing with something entirely different, described his new species, and compared it with *M. tomentosa* (Rich.) Don, to which it is of course related.

The geographic distribution of *M. amplexans* is peculiar. Cogniaux mentions it from Peru, Panama, and Trinidad, and it is still unknown from any intermediate stations in this rather large triangle. It extends south into Bolivia, whence it is represented by *Rusby 2251* and *Williams 780*, both distributed as *M. tomentosa*, and by *Buchtien 1736*, distributed as *M. amplexicaulis*. More recently it has been discovered in British Honduras, *Schipp 58*, where it becomes a tree 8 m. high.

In Amazonian Peru and adjacent Brazil it is one of the commonest species, but apparently does not extend west beyond the Department of Loreto. Our specimens include *KS 26917, 26933, 28052, W 677, 1473, 1577, 1633, 1698, 2049, 4259, K 88, 288*, and *1419*. This ample series is in general quite uniform, but a few need comment. In *K 88* the uppermost leaves are narrowly cuneate at base and not amplexicaul, while the lower leaves are typical; the veins are very slightly impressed. In *W 1577* the leaves are narrowly cuneate and distinctly petiolate, but the auricles are rounded; here also the veins are somewhat impressed. These two plants therefore approach *M. tomentosa*. In *W 1473, K 1419*, and *KS 26917* the pubescence of the lower leaf-surface is much softer and denser and composed of much larger stellate hairs.

§IV. *Octomeris*

MICONIA MURICATA (Don) Triana. Pozuzo: *Macbride 4573;* Dept. Junín, La Merced: *KS 23526, 24085*.

§V. *Laceraria*

MICONIA AUREOIDES Cogn. *KS 29528*, with calyx closed in bud, is referred here tentatively.

§VI. *Eumiconia*

MICONIA ALATA (Aubl.) DC. Manáos: *KS 30004;* Pará: *KS 30363*.

MICONIA ALBICANS (Sw.) Triana. Although a common lowland species in other parts of South America, we have it in recent collections only from altitudes of 600 m. or more. Dept. Junín, La Merced: *Macbride 5520*, San Ramón: *KS 24777;* Dept. Huanuco, Pampayacu: *Macbride 5103;* Dept. San Martín, San Roque: *W 7437, 7649*.

MICONIA AMPLEXICAULIS Naud. Dept. San Martín, San Roque: *W 7005*.

MICONIA AULOCALYX Mart. Dept. Loreto: *KS 27406, 29255, W 487, 5282*.

MICONIA BARBINERVIS (Benth.) Triana. Dept. Loreto: *KS 28071, W 1795, K 927;* Terr. Caquetá, Colombia: *Woronow & Juzepczuk 5994, Juzepczuk 6024*.

MICONIA CALVESCENS DC. Very common in the lowlands of Peru and down the Amazon to its mouth. Dept. Junín: *KS 25028, 26258, 26276, 26321, 26472, 26528, 26684;* Dept. Loreto: *KS 27396, 29560, 29688, W 297, 1479, 2116, 2457, 2876, 3314, 3367, K 1428;* Pará: *Dahlgren & Sella 125*.

MICONIA CANNABINA Markg. The type locality of the species is Iquitos and it seems to be abundant in the vicinity: *KS 27013, 27223, 29738, W 1493, 3663, 8154, K 1076*.

MICONIA CAPITATA Ule. Dept. Loreto, apparently common: *KS 27284, 28437, 29664, W 1327, 1338, 1634, 2993*.

MICONIA CERAMICARPA (DC.) Cogn. Near Pará: *Williams & Sella 45, KS 30309*. Although very common in the lowland forests near the coast, it does not extend far up the Amazon, where its place is taken by the related *M. nervosa*.

MICONIA CHAMISSOIS Naud. Dept. Loreto: *W 7982, KS 26902, 27178, K 339*.

Miconia clavistila sp. nov. §*Eumiconia Glomeratiflorae;* ramis, petiolis, inflorescentia, et hypanthio dense brunneo-tomentosis, pilis stipitato-stellatis; petiolis brevibus crassis; foliorum laminis late oblongis acutis basi rotundatis vel obscure subcordatis subintegris 3-nerviis, supra glabris praeter venam mediam tomentosam, subtus molliter stellato-pubescentibus; panicula sparse ramosa, ramis elongatis glomerulos terminales gerentibus; floribus 5-meris sessilibus; hypanthio parvo campanulato; calycis tubo longe producto; sepalis ovatis obtusis; petalis obovatis acutis inaequilateralibus; staminibus isomorphis; filamentis filiformibus; antheris linearibus, connectivo basi in lobos 2 breves laterales producto; ovario 3-loculare; stylo elongato, post anthesin superne incrassato.

Stems stout, densely tomentose above with brown, stalked, stellate hairs, the same indument covering the petioles, inflorescence, and hypanthium; petioles stout, 10–15 mm. long; blades oblong or somewhat obovate-oblong, firm, as much as 16 cm. long by half as wide, obscurely acuminate to an acute apex, very shallowly and irregularly crenate-serrate, rounded or slightly subcordate at base, 3-nerved; upper surface minutely stellate-tomentose along the midvein, otherwise opaque and glabrous; lower surface softly pubescent,

pecially on the primaries, with brown, short-stalked, stellate hairs; primaries ;htly impressed above, prominent beneath; secondaries nearly straight, 4–7 m. apart, ascending at an angle of about 70°, obscure and plane above, ırely elevated beneath; inflorescence a widely branching panicle about 10 cm. ng and wide, the opposite branches elongate, simple or once branched, each :anch bearing a single dense terminal glomerule of sessile 5-merous flowers; ypanthium fleshy, campanulate, 2.7 mm. long; calyx-tube prolonged 0.8 mm. › rounded sinuses; sepals broadly ovate-triangular, 1.2–1.3 mm. long, obtuse, :ect; exterior teeth almost wholly adnate, stoutly triangular, the free tip 0.2 ım. long, conspicuously surpassed by the sepals; petals obliquely obovate, .8 mm. long, 2.2 mm. wide, sharply acute and strongly inequilateral, comletely but minutely stellate-pubescent without; stamens isomorphic; filaıents filiform, 5 mm. long; anthers linear, 4.5 mm. long, opening by a minute erminal pore; connective 2-lobed at base and curved anteriorly into 2 lateral, :carcely diverging lobes; ovary half-inferior, 3-celled, its rounded summit ensely but minutely pubescent around the style-base; style straight and lender, 8 mm. long, glabrous, in age becoming conspicuously thickened disally; stigma truncate, 0.7 mm. in diameter.

Type, *W 373*, collected on the lower Río Nanay, Dept. Loreto, Peru. According to the arrangement of species by Cogniaux, it appears to be 'elated to *M. barbinervis* (Benth.) Triana and *M. stelligera* Cogn., particuarly the latter, but differs from both in leaf-form and elongated style.

Miconia compacta sp. nov. §*Eumiconia Glomeratiflorae*; ramis teretibus lense brunneo-stellato-tomentosis; petiolis crassis brevibus dense tomentosis; .aminis membranaceis ellipticis acutis vel abrupte acuminatis integris basi rotundatis 3-nerviis vel 3–5-pli-nerviis, supra ad venas primarias sparse tomentosis ceterum glabris, subtus dense stellato-pubescentibus; panicula racemiforme contracta confertiflora tomentosa, ramis lateralibus brevissimis, bracteis persistentibus; floribus 6-meris in glomerulis terminalibus sessilibus; hypanthio campanulato stellato-tomentoso; sepalis reflexis ovatis obtusis e sinubus angustis; petalis anguste obovatis basi cuneatis; filamentis anguste clavatis glandulosis; antheris linearibus dimorphis, connectivo majorum dorso tuberculato, basi breviter producto glandulosoque, minorum breviter producto ad basin glanduloso; ovario 3-loculare glanduloso; stylo glabro, stigmate ovoideo.

Stems woody, 1–4 m. high, the upper branches terete, densely stellate-tomentose with brown hairs; petioles stout, 8–17 mm. long, tomentose like the stem; blades elliptic, 9–17 cm. long by half as wide, acute or abruptly acuminate, entire, rounded at base, normally 3-nerved, but in a few leaves distinctly 3–5-pli-nerved, glabrous above except a small strip of stellate tomentum along the primaries, freely but loosely stellate-pubescent below, more densely on the veins; principal veins nearly plane above, elevated beneath, the secondaries 5–8 mm. apart, ascending at an angle of 70°, the tertiaries

reticulate beneath; panicles contracted, 5–8 cm. long, densely stellate-tomentose, the lateral branches 3–5 mm. long; bracts lanceolate, persistent, 2–3 mm. long, densely tomentose; flowers sessile in small terminal glomerules, 6-merous; hypanthium campanulate, 3.2 mm. long to the torus, loosely but continuously tomentose with sessile, cinereous, stellate hairs; calyx-tube not prolonged; sepals reflexed, broadly ovate, 1.3 mm. long, 1 mm. wide, obtuse, pubescent like the hypanthium but less densely, the sinuses very narrow; exterior teeth reduced to minute subapical protuberances; petals narrowly obovate-spatulate, 4 mm. long, 1.8 mm. wide, cuneate at base, rounded above, glabrous, the margins and apex somewhat involute and cucullate; stamens dimorphic; large stamens: filaments flattened, narrowly spatulate, 3.2 mm. long, freely glandular except on the back; anthers nearly straight, linear, 3.6 mm. long, the connective much thickened below the middle, with a small dorsal protuberance, prolonged 0.4 mm. below the pollen-sacs into a fleshy, freely glandular base; small stamens: filaments 2.7 mm. long, very narrowly spatulate and sparsely glandular; anthers arcuate, 2.8 mm. long, the connective much thickened basally and prolonged 0.3 mm., sparsely glandular at the very base only; ovary half-inferior, 3-celled with numerous ovules, the free summit truncate-conic, minutely glandular-punctate; style stout, glabrous, at least 4 mm. long; stigma large, ovoid.

Type, *KS 26936*, collected in forest at Iquitos, Dept. Loreto, Peru, alt. about 100 m.; other specimens from the same place are *KS 27354* and *K 1050*. The same species was also collected at Iquitos by Tessmann, numbers *3648* and *3612*. *M. compacta* appears to be related to *M. glomerata* Triana, to which the Tessmann collections have been referred at Berlin. That species has much narrower leaves truncate or cordate at base, 5-merous flowers, and very short, broadly rounded sepals.

MICONIA DIPSACEA Naud. Dept. Ayacucho: *KS 22411;* Dept. Junín, La Merced: *KS 23505*, *Macbride 5541*, Huacapistana: *KS 24516*.

MICONIA ERIOCALYX Cogn. A tree 8–10 m. high, Dept. Loreto, Yurimaguas: *KS 27593*.

MICONIA ERIOCLADA Triana. Common at altitudes of less than 700 m., Dept. Junín: *Macbride 5546*, *KS 23469, 25070, 25221, 25372, 26469;* Dept. San Martín: *W 6758;* Dept. Loreto: *KS 27835, 29504, 29554, W 294, 3210, 4940, 4999*.

MICONIA EUGENIOIDES Triana. Dept. Loreto, La Victoria: *W 2966*, without flowers. The specimen has narrower leaves than the type and is referred here with considerable reluctance.

MICONIA FALLAX DC. Dept. Junín, San Ramón: *KS 24775*, an aberrant form with longer leaves.

MICONIA HETEROMERA Naud. Dept. Loreto: *W 2688, 2985, 3011*. Our specimens, which are totally glabrous on the leaves and only thinly fur-

furaceous on the petioles and stem, are referred tentatively to this species, which is described as setulose on the leaves and hirsute on the petioles. This may be due to the age of the specimens, ours being fully mature, or to geographic differentiation, ours being from the lowlands near Iquitos, while the original is from Maynas Alto. The similarity of leaf-shape is striking.

MICONIA IBAGUENSIS (Bonpl.) Triana. Dept. Junín: *Macbride 5534, 5488, KS 24781;* Dept. Huanuco: *Macbride 5020;* Dept. San Martin: *W 5380, 5630, 6151, 6428, 7530.*

MICONIA JURUENSIS Pilger. Dept. Loreto, lower Río Nanay: *W 481.* The specimen agrees excellently with the type, *Ule 5827*, in the Berlin herbarium.

MICONIA LEPIDOTA DC. Dept. Loreto: *KS 29954, W 4036;* Manáos: *KS 30123;* Pará: *KS 30495.*

Miconia longiracemosa sp. nov. § *Eumiconia Paniculares;* ramis glabris, internodis complanatis mox subteretibus; foliis anguste ellipticis, breviter acuminatis, subintegris, basi in petiolum brevem alatum cuneatis, 3-plinerviis, utrinque glabris, subtus angustissime reticulatis; pedunculis compressis, paniculae ramis lateralibus multo elongatis; floribus 5-meris, sessilibus aut brevissime pedicellatis; hypanthio tubuloso-campanulato, minutissime rubropunctato; sepalis erectis, triangularibus, acutis, dentibus exterioribus subulatis quam sepalis brevioribus; petalis obovato-oblongis; antheris linearibus dimorphis, connectivo exteriorum basi in appendicem latam rotundatam, interiorum in calcar dorsale breve et lobos 2 laterales deflexos producto; ovario 4-loculare.

Stems woody, apparently sparsely branched, glabrous, the upper internodes conspicuously compressed, later filling out to roundly 4-angular and eventually subterete; leaf-blades firm, narrowly elliptic, 12–25 cm. long by a third as wide, abruptly acuminate, nearly or quite entire, cuneate at base into a winged petiole 15–20 mm. long, 3-pli-nerved, glabrous; primaries and secondaries impressed above, elevated beneath, the latter 5–8 mm. apart, ascending at an angle of about 70°, tertiaries obsolete above, very finely reticulate beneath; panicles large and freely branched, 15–20 cm. long, glabrous, the internodes conspicuously flattened, the lateral branches greatly elongate; flowers 5-merous, mostly in glomerules of 2, of which one is sessile and the other short-pedicelled; hypanthium tubular-campanulate, 2.4 mm. long to the torus, obscurely 10-ribbed, minutely verruculose and sparsely furfuraceous with reddish, probably substellate hairs; calyx-tube somewhat flaring, prolonged about 0.4 mm., sepals erect, triangular, acute, 0.5 mm. long, exterior teeth subulate, shorter than the sepals; petals obovate-oblong, 1.5 mm. long by 1.1 mm. wide, slightly inequilateral, obscurely retuse, thinly pulverulent externally; anthers stoutly linear, opening by a minute terminal pore, dimorphic; connective of the larger prolonged 0.4 mm. at base into a single semicircular

flat organ, that of the smaller prolonged 0.2 mm. into a triangular dorsal and 2 broadly triangular, deflexed lateral lobes; ovary half-inferior, 4-celled, its free summit glabrous, truncate-conic, sharply 10-ribbed and minutely 10-toothed.

Type, *W 4249*, collected on the lower Río Huallaga, Dept. Loreto, Peru, alt. 155–210 m.; other specimens from the same region, or from the Río Itaya and Río Nanay, are *W 115*, *604*, *3296*, *3878*, *4038*, *4167*, and *4349*.

Superficially this species bears a strong resemblance to *M. pteropoda* Benth., which grows in the same region and with which it was at first confused, until the arrival of the later numbers provided flowering material for more exact comparison. The stamens of *M. pteropoda* are isomorphic and the connective is divided at base into two lateral lobes which are strongly deflexed anteriorly. Even in sterile condition the two may be distinguished by the venation. In *M. pteropoda* the vein-areoles on the lower side of the leaf are usually more or less oblong and always exceeding 1 mm. in their smallest dimension; in *M. longiracemosa* they are nearly always 5–6-sided and only 0.3 mm. across.

At the present time the value of the anther-connective in the classification of *Miconia* is not fully known. Whether these two species should be regarded as related because of their superficial similarity, or separated because of their differences in anthers, must wait until the whole genus is more thoroughly studied.

Miconia Martiniana sp. nov. §*Eumiconia;* ramis juvenilibus compressis bisulcatis densissime brunneo-furfuraceo-tomentosis; petiolis brevissimis crassis dense tomentosis; foliorum laminis magnis anguste obovato-oblongis satis acuminatis leviter undulato-serratis e media ad basin subcordatam angustatis 5-pli-nerviis, supra primum stellato-pubescentibus mox glabris nitentibus ad venam mediam tomentosis, subtus molliter stellato-pubescentibus praecipue ad venas; inflorescentia subsimplice ramis paucis elongatis stellato-tomentosis; floribus 5-meris sessilibus secus ramos inflorescentiae in glomerulos dense confertis; hypanthio campanulato tomentoso; sepalis brevissimis triangularibus e sinubus rotundatis, dentibus exterioribus nullis; petalis parvis cuneatis inaequilateralibus retusis extus stellatis; filamentis gracilibus; antheris dimorphis linearibus poro minuto dehiscentibus, connectivo ad basin dilatato et (ser. ext.) in lobos 2 tortos laterales et 2 dorsales minutos vel (ser. int.) in lobos 2 laterales graciles et 1 dorsalem producto; ovario semi-infero, 3-loculare, summo conico pubescente in lobos 5 erectos producto; stylo glabro; stigmate capitato.

Upper internodes alternately flattened, shallowly 2-sulcate, very densely furfuraceous-tomentose; petioles stout, 3–5 mm. long, tomentose like the

stem; leaf-blades firm, narrowly obovate-oblong, as much as 9 by 26 cm., rather abruptly acuminate, inconspicuously undulate-serrulate, narrowed from above the middle to a cordate base, 5-pli-nerved, the upper side at first stellate-pubescent, soon becoming glabrous and shining, but persistently tomentose on the midvein, the lower side brown, densely and softly stellate-pubescent, especially on the veins; primaries and secondaries impressed above, strongly elevated beneath, the latter 7–9 mm. apart, ascending at an angle of about 75° and nearly straight, the tertiaries obsolete above, reticulate beneath; inflorescence densely stellate-tomentose, with a few straight, elongate, 4-sulcate branches bearing each several crowded glomerules of sessile 5-merous flowers; hypanthium narrowly campanulate, 2.8 mm. long, densely tomentose with pale brown stellate hairs; calyx-tube prolonged 0.8 mm. erect, pubescent like the hypanthium; sepals triangular, acute, 0.3 mm. long, from broadly rounded sinuses, pubescent like the hypanthium; exterior teeth not differentiated; petals cuneate, 2.7 mm. long, inequilateral, irregularly retuse, stellate-pubescent on the outside, mostly near the tip; stamens dimorphic; filaments slender, 3.5 or 3 mm. long; anthers linear, straight, 4.5 or 3 mm. long, opening by a minute terminal pore; connective expanded at base into (large anthers) 2 conspicuous, somewhat spiral lateral lobes and 2 minute dorsal lobes or (small anthers) 2 very slender lateral lobes and 1 minute dorsal lobe; ovary half-inferior, 3-celled, the conic summit minutely pubescent and prolonged into 5 erect flat lobes 0.6 mm. long; style glabrous, 7 mm. long; stigma capitate, 0.7 mm. in diameter.

Type *W 7212*, collected at San Roque, Dept. San Martín, Peru, alt. 1350–1500 m. The plant resembles in appearance and is related to *M. phanerostila* Pilger, which has much longer sepals, glandular connective, truncate stigma, and decurrent leaves.

MICONIA MATTHAEI Naud. Dept. Loreto, Masisea: *KS 26854*.

Miconia membranicalyx sp. nov. §*Eumiconia Glomeratiflorae;* ramis juvenilibus dense tomentosis mox glabrescentibus subteretibus; petiolis crassis brevibus dense tomentosis; laminis anguste ellipticis acuminatis integris basi obtusis 3-nerviis, supra ad basin venae mediae tomentosis ceterum glabris, subtus stellato-pubescentibus, venis lateralibus ad marginem proximis; inflorescentia parva dense tomentosa, ramis lateralibus circa 4; hypanthio campanulato dense stellato-tomentoso; sepalis erectis triangularibus membrano connatis, dentibus exterioribus triangularibus crassis sepala obtegentibus; petalis obovatis inaequilateralibus; antheris majoribus basi in appendicem crassam obliquam subcordatam productis, minoribus in appendicem dilatatam 5-lobatam expansis; ovario 5-loculare pauciovulato.

Stems woody, subterete, densely tomentose when young with dull brown, stellate hairs, glabrescent below; petioles very stout, 8–12 mm. long, tomentose like the stem; blades thin, narrowly elliptic, 11–16 cm. long, 3.5–5 cm.

wide, acuminate, obtuse at base, entire, glabrous above, except for a short line of tomentum along the base of the midvein, freely stellate-pubescent on the lower side, somewhat more densely on the veins, 3-nerved, the laterals only 2–3 mm. from the margin; primaries and secondaries impressed above, elevated beneath, the latter averaging 6 mm. apart, ascending at an angle of 70°, the tertiaries obsolete above, scarcely reticulate beneath; inflorescence about 3 cm. long, its stout axes densely tomentose, the lateral branches 3–4 mm. long and about 4 in number; flowers 5-merous, sessile in dense glomerules; hypanthium broadly campanulate, 2 mm. long to the torus, densely stellate-tomentose; calyx-tube prolonged 0.7 mm; sepals thin, glabrous, narrowly triangular, 0.4 mm. long, connected by a delicate membrane, completely concealed by the thick, broadly triangular, obtuse, densely tomentose exterior teeth; petals narrowly obovate, 4 mm. long by 2.4 mm. wide, very unsymmetrical; large stamens: filaments slender, 5 mm. long; anthers stoutly linear, 3.3 mm. long, the connective prolonged 0.8 mm. below the pollen-sacs and dilated into a fleshy, oblique, subrotund or broadly cordate appendage surrounding the filament; small stamens: filaments slender, 4.2 mm. long; anthers stoutly linear, 2.4 mm. long, the connective prolonged 0.7 mm. below the pollen-sacs, divided on the ventral side, and dilated into a triangular, 5-lobed appendage surrounding the filament; ovary 5-celled, with few ovules in each cell; style straight, slender, glabrous, 7 mm. long, the stigma barely expanded, 0.5 mm. in diameter.

Type, *Dahlgren & Sella 522*, collected at Pará, Brazil. *M. membranicalyx* is closely related to *M. multispicata* Naud., of the West Indies and Trinidad, and the undescribed *M. ruficalyx* Gleason, of British Guiana. All three agree in the general structure of the inflorescence, the membrane connecting the sepals, the dimorphic stamens with greatly prolonged connective, and the small number of ovules. Our species is separated from the other two by its narrower leaves, its much reduced inflorescence, its strongly inequilateral petals, and its 5-celled ovary.

MICONIA MOLLIS Triana. Dept. San Martín, Alto Río Huallaga: *W 6718*. This station is not far from the type locality at Tarapoto and the species was also collected in the same general region by Mathews. It is not well differentiated from *M. Schwackei* Cogn.

MICONIA NERVOSA (Sm.) Triana. Dept. Junín: *KS 26225, 26339, Macbride 5811;* Dept. San Martín: *W 6074;* Dept. Loreto: *KS 26855, 27576, 27937, 27967, 28560, 28745, 29665, W 685, 784, 801, 1598, 1869, 2043, 2321, 2581, 3083, 3728, 3729, 3879, 4344, 4700, 4801, 8231.*

Miconia nobilis sp. nov. §*Eumiconia Impetiolares;* ramis crassis, obtuse 4-angulatis, dense fusco-tomentosis; petiolis triquetris brevissimis; laminis maximis membranaceis obovatis acuminatis integris basi acutis 5-pli-nerviis supra glabris subtus ad venas sparse et ad paginam sparsissime breviterque

lanatis; panicula ampla ramosa lanata; floribus 5-meris in glomerulis pauci-floris sessilibus; hypanthio campanulato tenuissime stellato; sepalis brevissimis late rotundatis; petalis obovato-oblongis; staminibus subdimorphis linearibus, connectivo infra thecis breviter producto at ad marginem glanduloso; ovario 3-loculare; stylo breve crasso glabro, stigmate capitato.

A tree 4–5 m. high, the stout upper branches roundly 4-angled and densely lanate or tomentose with brown hairs; petioles stout, 1 cm. long, 3-angled; blades thin, obovate, as much as 46 cm. long by half as wide, abruptly acuminate, entire, acute at base, 5-pli-nerved, the outer pair submarginal, veins plane above, the secondaries about 1 cm. apart, ascending at an angle of about 75°, primaries and secondaries prominently elevated beneath, the numerous tertiaries plane and finely reticulate; upper surface glabrous, the lower side very thinly and sparsely lanate with short appressed hairs, most abundant on the veins; panicle 20 cm. long, freely branched, its strongly sulcate branches densely brown-lanate; flowers 5-merous, sessile in small, few-flowered, lateral glomerules; hypanthium campanulate, 2.7 mm. long to the torus, very thinly and minutely stellate-pubescent, soon glabrous; calyx-tube prolonged 0.6 mm.; sepals depressed-rounded, 0.2 mm. long, from broadly rounded sinuses, the exterior teeth reduced to minute verrucosities; petals rather thick, obovate-oblong, 2.8 mm. long, 1.9 mm. wide; anthers somewhat dimorphic, linear, opening by a minute terminal pore, 3.3 or 2.8 mm. long; connective prolonged about 0.3 mm. below the thecae, that of the large anthers dilated into a single truncate lobe nearly surrounding the filament, with 4–7 sessile glands on the margin of each side, that of the small anthers divided dorsally into 2 rounded lateral lobes, each with 1–4 marginal glands; ovary 3-celled with numerous ovules; style (perhaps not fully expanded) stout, terete, glabrous, 2.7 mm. long, the capitate stigma 0.8 mm. in diameter.

Type *KS 26006*, collected in dense forest at San Nicolas, on the Pichis Trail, Dept. Junín, Peru, alt. 1100 m. The calyx was noted as rich pink, the corolla white. The species is related to a small group including such well-known forms as *M. dipsacea* Naud., *M. impetiolaris* (Sw.) Don, and *M. amplexicaulis* Naud.; to this group have recently been added *M. falcata* Cogn. and *M. phanerostila* Pilger. The closer affinity of our species to the last is shown by the striking similarity of the glandular anthers. Pilger's plant differs from *M. nobilis* in its much smaller, elliptic, long-petioled leaves, its tomentose hypanthium, and its large triangular sepals.

MICONIA POEPPIGII Triana. *M. congesta* Cogn. Dept. Loreto: *W 2900, 3340, 3698, 4147, 4373, 4548;* Bolivia, Mapiri: *Buchtien 1680* (type of *M. congesta*). A careful examination of Cogniaux' species fails to reveal any difference between it and the Peruvian plants.

MICONIA PRASINA (Sw.) DC. Dept. Loreto: *KS 27391, 28929, W 572, 974, 2936, 4807.*

Miconia pteropoda Benth. Dept. Loreto: *W 1636, 2707, 2987;* near Pará: *KS 30462.*

Miconia radulaefolia Naud. Dept. Loreto: *KS 27307, 29662.*

Miconia riparia Triana. Dept. Loreto, Río Maranon Valley: *KS 29136.* It is doubtful if *M. persicariaefolia* Cogn. can be kept separate.

Miconia rufescens (Aubl.) DC. Dept. San Martín, Tarapoto: *W 5422.*

Miconia scorpioides (Schl. & Cham.) Naud. Dept. Loreto, Lower Río Huallaga: *W 4266, 4607.*

Miconia serialis DC. Dept. Loreto: *KS 27544, 27948, 28077, 29857, 29995, W 1454, 1508, 3631, 3836, 4718, K 36.*

Miconia spennerostachya Naud. *M. Aspiazui* Macbr., *M. nectaria* Macbr. Dept. Loreto, a small tree at Pebas: *W 1686*, a shrub between Yurimaguas and Balsapuerto: *KS 28131.* The most conspicuous external feature of the species is a series of cyathiform glands along the upper part of the petiole or the base of the blade, while dissection shows that the anthers are glandular at base. It was also collected in Peru by Mathews (type) and Pearce, and extends south into Bolivia: *Rusby 2268, 2278, Steinbach 7173.* The latter has been elsewhere identified as *M. coronata* (Bonpl.) DC., which is quite a different plant, of the section *Tamonea*, growing in the Andes of Colombia. I can not distinguish Macbride's plants from this species.

Miconia stenostachya DC. Dept. Ayacucho: *KS 22705;* Dept. San Martín: *W 5423, 5629, 5678, 6330, 6419, 6427.*

Miconia tetrasperma sp. nov. §*Eumiconia Paniculares;* ramis gracilibus arcte furfuraceis; petiolis brevibus furfuraceis; foliorum laminis elliptico-oblongis utrinque acutatis integris 5-nerviis, supra glabra nitidula, subtus opacis brunneis tenuissime stellatis praecipue ad nervos; panicula sessile folia terminalia subaequante, ramis angulatis tenuiter stellatis; floribus sessilibus 5-meris; hypanthio late campanulato parvo stellato; calyce in alabastro fere clauso, ad anthesin in lobos 2–4 late triangulares lacero et mox deciduo; petalis anguste ellipticis acutis reflexis; staminibus dimorphis; filamentis gracilibus; antheris linearibus poro terminale dehiscentibus; connectivo infra thecis productis in lobum unicum dorsalem et lobos 2 latero-ventrales; ovario 4-loculare; ovulo 1 in quoque loculo; stylo elongato, stigmate truncato; baccis 4-spermis, seminibus magnis.

A shrub or small tree, the younger branches somewhat flattened, slightly swollen at the nodes, and very closely and minutely brown-furfuraceous; petioles angular, 8–12 mm. long, pubescent like the stem; leaf-blades rather firm, elliptic-oblong, those of the flowering branches as much as 12 by 5 cm., acuminate to an obtuse apex, entire, broadly acute at base, 5-nerved, the outer

pair submarginal, glabrous and somewhat shining above when mature, very sparsely stellate when young, minutely and sparsely stellate beneath, especially on the veins; panicle sessile, freely branched, 6–10 cm. long, its branches obscurely 4-angled, uniformly and thinly stellate; apparent pedicels up to 1.5 mm. long, minutely bibracteolate at the summit, the actual pedicels 0–0.3 mm. long; hypanthium broadly campanulate, stellate like the pedicels, 1.1–1.3 mm. long to the torus; calyx continuous and almost closed in bud, split at anthesis into 2–4 broadly triangular lobes extending nearly or quite to the torus, the lobes irregular in width, about 0.8 mm. long, acute to obtuse, soon deciduous; petals narrowly elliptic, subacute, reflexed at anthesis, 2.3 mm. long, minutely furfuraceous distally; stamens dimorphic; filaments very slender, 2 or 2.5 mm. long; anthers stoutly linear, 1.6 or 2 mm. long, opening by a small terminal pore, the basal two fifths sterile; connective prolonged below the thecae and dilated at base into (small stamens) a slender dorsal and two stouter lateral lobes or (large stamens) an oblique, flat, triangular organ with the dorsal lobe prominently spreading; ovary half-inferior, 4-celled, with a single ovule in each cell, free summit rounded, glabrous; style glabrous, slender, 3 mm. long; stigma truncate or punctiform.

Type *W 3757*, collected at Iquitos, Dept. Loreto, Peru. Other specimens are *K 265*, with stamens a trifle larger and at least some of the flowers 6-merous; *W 1520*, in fruit, the berries spherical, 4-seeded, each seed 3.2 mm. long; *W 2753*, *3693*, still in bud, but agreeing with the type in all respects. All of these are from the immediate vicinity of Iquitos.

In searching for other species with which *M. tetrasperma* may be compared, one is led to *M. eugenioides* Triana. This little known species is represented in herbaria only by the type collection, *Spruce 3531*, from the Río Casiquiare. In general habit, it is very much like our species, and this similarity extends to the details of pubescence and floral structure with such remarkable fidelity that I have hesitated long before describing ours as new. The differences between the two species are as follows: All flower parts in *M. eugenioides* are a third to a half larger than in *M. tetrasperma*, except the petals, which are 70–90% larger; the calyx seems to split into 5 perfectly uniform sepals; there are about 10 ovules in each cell of the ovary, the leaves are shorter, proportionately narrower, acuminate to a sharper point, and sub-3-pli-nerved.

MICONIA STELLIGERA Cogn. Dept. Junín: *KS 24635*, *24689*, *25721*, *26483;* Dept. Loreto: *KS 27575*, *27598*, *28190*, *28960*, *29332*, *29474*, *W 3281*, *4398*, *5093*.

MICONIA TILIAEFOLIA Naud. Dept. Junín, San Ramón: *KS 24792*, La Merced: *Macbride 5331*.

MICONIA TRIPLINERVIS R. & P. Dept. Ayacucho: *KS 22908*, *23090;*

Dept. Junín: *KS 23618, 24729, 25247;* Dept. San Martín: *W 6958;* Dept. Loreto: *KS 28805, W 4950, 5094, 5278, 5343.*

§VII. *Glossocentrum*

MICONIA CENTRODESMA Naud. Dept. Loreto, Manfinfa on the upper Río Nanay: *W 1127*, identified by foliage resemblances alone.

MICONIA EGENSIS Cogn. Dept. Loreto: *W 1637, 2703.*

Miconia icosandra sp. nov. § *Glossocentrum*, ubique fere glabra; ramis obtuse 4-angulatis crassis; petiolis gracilibus brevibus; foliorum laminis membranaceis anguste oblongis acuminatis integris basi acutis sub-5-pli-nerviis; panicula ampla ramosa; floribus 5-meris confertis, terminalibus sessilibus, alaribus brevissime pedicellatis; hypanthio hemisphaerico; sepalis late triangularibus acutis e sinubus rotundatis, dentibus exterioribus subobsoletis; petalis obovato-oblongis, oblique retusis, utrinque minute pulverulentis; staminibus circa 20 isomorphis; filamentis filiformibus glabris; antheris linearibus obtusis poro lato ventro-terminale dehiscentibus; connectivo basi breviter producto in lobum dorsalem oblongum et lobos 2 laterales late rotundatos; ovario 4-loculare infero summo truncato glabro, placentis fere basalibus in loculos radiatim productis, ad basin ovarii adnatis, ovulis in quoque loculo 10–13; stylo elongato; stigmate capitato.

Small tree, glabrous throughout; younger stems rather prominently flattened with internodes 2–4 cm. long; petioles slender, 15–25 mm. long; leaf-blades membranous, narrowly oblong, broadest somewhat above the middle, as much as 16 cm. long by a third as wide, acuminate to a slender cusp 1 cm. long, entire, acute at base, sub-5-pli-nerved, obscurely and minutely pulverulent on the lower surface; veins all lightly impressed and finely but obscurely reticulate above, conspicuously elevated beneath, the secondaries 4–6 mm. apart, ascending at an angle of about 80°; inflorescence paniculate, about 15 cm. long, with spreading branches; flowers 5-merous, crowded in small cymules, the terminal sessile, the lateral on very short pedicels; hypanthium hemispheric, glabrous, 2 mm. long to the torus; calyx-tube somewhat flaring, prolonged 0.3 mm. to rounded sinuses; sepals broadly triangular, acute, 0.4 mm. long, the exterior teeth reduced to scarcely apparent thickenings; petals obovate-oblong, 3 mm. long, 2.2 mm. wide, obliquely retuse, minutely pulverulent distally on both sides; stamens about 20, isomorphic; filaments filiform, slightly flattened, 2.8 mm. long; anthers broadly linear, 2-celled, 2.4–2.6 mm. long, opening by a broad terminal pore; connective expanded below and prolonged 0.6 mm. below the thecae into an oblong medio-dorsal lobe and 2 small, rounded, latero-ventral lobes; ovary wholly inferior, 4-celled, its top flat or slightly depressed; placentae nearly basal, extending radially into the loculi and adnate to the bottom of the ovary, each with 10–13 ovules on its upper side; style straight, erect or declined, 6 mm. long; stigma capitate, 0.7 mm. in diameter.

Type, *KS 25781*, collected at Eneñas, on the Pichis Trail, Dept. Junín, Peru, alt. 1600–1900 m. In almost every flower there are some sterile filaments. Including them, the number of stamens varies from 17 to 21, but in at least half of the flowers exactly 20 were counted. The arrangement of the placentae is most unusual. There are other species of the genus in which the ovules are reduced to one in each cell, located at the base of the ovary, but this seems to represent a mere shortening of the usual axial placenta. In this species, the placenta is actually adnate to the bottom of the ovary. Genera have been described on morphological grounds of less importance, and the difference in placentae between the three subfamilies of Melastomataceae is of the same general order as the difference between this and the ordinary structure of *Miconia*. I know of no other species in the genus with which it may well be compared, but its position seems to be in § *Glossocentrum*.

Miconia Klugii sp. nov. § *Glossocentrum;* ramis crassis, obtuse 4-angulatis, minutissime arcte lepidotis; petiolis elongatis lepidotis; foliis magnis ellipticis abrupte acuminatis integris basi acutis 3-pli-nerviis supra glabris subtus dense lepidotis; floribus paniculatis sessilibus 5-meris, inflorescentia lepidota; hypanthio campanulato lepidoto; sepalis minutis; petalis cuneato-obovatis; antheris linearibus poro lato dehiscentibus, connectivo basi in lobum rotundatum producto; ovario 3-loculare, stylo breve subclavato, stigmate truncato.

Stems stout, roundly 4-angled, very closely and minutely lepidote; petioles stout, strongly angled, 2–6 cm. long, lepidote like the stem; blades firm, elliptic, as much as 23 cm. long by half as wide, acuminate, entire, broadly acute at base, 3-pli-nerved, glabrous and shining above, densely covered beneath with a thick brown indument of lepidote hairs; primaries and secondaries strongly impressed above, elevated beneath, the latter 5–8 mm. apart, ascending at an angle of about 60°; inflorescence paniculate, freely branched, 20 cm. long, closely but thinly lepidote; flowers 5-merous, sessile and densely crowded on short lateral branches; hypanthium campanulate, 1.3 mm. long to the torus, where it is slightly constricted, densely brown-lepidote, its walls thick and fleshy; calyx-tube erect, 0.5 mm. long, lepidote like the hypanthium, the sepals reduced to minute points only 0.1 mm. long; petals cuneate-obovate, 1.8 mm. long, 1 mm. wide, obliquely truncate or slightly retuse, inequilateral; stamens isomorphic; filaments very slender, 2 mm. long; anthers linear, 1.8 mm. long, opening by a wide terminal pore; connective prolonged 0.3 mm. at base and dilated into a rounded, obscurely lobed appendage; ovary very small, half-inferior, 3-celled, its free summit rounded and glabrous; style 2.5 mm. long, gradually thickened upward and 0.4 mm. in diameter at the truncate stigma.

Type, *K 1141*, collected in forest at Mishuyacu, near Iquitos, Dept. Loreto, Peru, alt. 100 m.; it is described as a tree 10 m. high. Our species

stands quite isolated from other Peruvian members of the section *Glossocentrum* and is characterized among them by its conspicuous lepidote pubescence. It is apparently more closely related to *M. chartacea* Triana and other similar species of southern Brazil.

MICONIA LONGIFOLIA (Aubl.) DC. Dept. Loreto: *KS 28103, 29777, W 3280, 3402, 3506, 4769, 4912, 5350.*

MICONIA MARTIUSIANA DC. Dept. Loreto, Mishuyacu: *K 22, 1082, 1090.*

MICONIA MINUTIFLORA (Bonpl.) DC. Dept. Junín: *KS 24627, Schunke 422;* Dept. San Martín: *W 5628, 6425, 7103;* Dept. Loreto: *W 1616, K 736;* Pará: *Dahlgren & Sella 195, 481.*

MICONIA PILGERIANA Ule. This well marked species, originally collected on the Juruá River in Brazil, appears to be common in Amazonian Peru in Dept. Loreto: *KS 28389, W 1714, 1718, 1779, 2319, 3339, K 1350.* Its stamens are especially distinctive, the basal half or somewhat more being sterile and nearly terete, while the distal portion broadens out into obovate fertile pollen-sacs opening by a wide terminal pore. In this feature it is extraordinarily like *M. stellipilis* Cogn., from Bolivia, the type of which is at the New York Botanical Garden. In fact, the stamens of the two species are indistinguishable in form or dimensions and the distinction lies in the shape of the petals and the character and amount of pubescence on the stem and leaves. Both Cogniaux and Ule placed their species in the section *Cremanium.* The former evidently mistook the sterile anther-base for a connective, since he reported the anthers as about 0.5 mm. long; the latter says the anthers are cuneate, 2-pored and glabrous, although I failed personally to find any anthers visible on the type specimen at Berlin, which seems to be entirely in fruit. In both species the filaments are but slightly flattened, quite slender, and with no trace of the geniculation which is so characteristic of most species of *Cremanium.* The anther taken as a whole is certainly linear and I believe both species properly belong in section *Glossocentrum.*

MICONIA PUBERULA Cogn. Dept. Junín: *KS 24790;* Dept. San Martín: *W 5702, 6150,*

MICONIA TERNATIFOLIA Triana. Dept. Ayacucho: *KS 22419, 22946;* Dept. Junín: *Macbride 5344, KS 24156;* Dept. San Martín: *W 6393, 7054, 7222, 7676.*

§VIII. *Chaenanthera*

MICONIA CHRYSOPHYLLA (Rich.) Urban. Dept. Loreto: *KS 27032, 27530, W 3660, 4809.*

MICONIA DICHROPHYLLA Macbr. Dept. Junín: *KS 26379, Macbride*

5495 (duplicate of the type); Dept. San Martín; *W 5891, 6421, 6472, 6586;* Dept. Loreto: *W 4886;* Bolivia, *Williams 757* (det. by Cogniaux as *M. fulva* DC.), *Buchtien 1711* (doubtfully det. by Cogniaux as *M. chartacea* Triana), *Bang 2650* (doubtfully det. by Cogniaux as *M. elaeagnoides* Cogn.). Of this whole series, only the last is in flower, the remainder exhibiting fruits or immature buds. An examination of the stamens in this one shows that they are stoutly linear, opening by a fairly wide terminal pore, the connective briefly prolonged at base and bearing two dorsal and two latero-ventral spurs; the calyx is essentially truncate, the sepals reduced to 5 minute teeth only 0.2 mm. long. The habit of the plant is so much like *M. chrysophylla* (Rich.) Urb. (*M. fulva* DC.) that a place for the species in section *Chaenanthera* is at once suggested, to which *M. elaeagnoides* also belongs. The former species has 3-nerved leaves, while in ours they are 5-pli-nerved, in which they agree with the description of *M. elaeagnoides.* A careful study of the original description of this species shows that our plants agree with it in all save two characters. The size of the leaves is stated as 20–30 cm. long by a third as wide; on our plants a few leaves can be found with this proportion, but not of this size, the largest being somewhat less than 20 cm. The sepals are described as linear-subulate, while ours are extremely short and triangular. But it also appears that Cogniaux never saw the stamens, which he says are unknown, so that he must have guessed at the section to which it belongs, and must also have had to estimate the shape of the sepals in flower from their appearance in fruit. Three European herbaria have given no help in the matter, there being no specimens of *M. elaeagnoides* at Berlin or Kew, while the single sheet so labeled at Geneva is *Poeppig 2458* instead of *2558* and of quite a different species.

In summary, I believe that Macbride's species is nothing more than the poorly known *M. elaeagnoides* Cogn., but pending examination of authentic material his name will be continued for our specimens. If this belief is correct, the species will need to be transferred from section VIII to *Eumiconia Seriatiflorae.*

MICONIA DOLICHORRHYNCHA Naud. Dept. Junín, La Merced: *Macbride 5589* (typical), Pichis Trail: *KS 25889* (terminal acumen poorly developed).

MICONIA REGELII Cogn. *KS 30012* and *30107*, from Mánaos, seem to agree fairly well with this species.

§IX. *Amblyarrhena*

MICONIA CILIATA (Rich.) DC. Pará: *KS 30279, Dahlgren & Sella 222, 254.*

MICONIA CRASSIFOLIA Triana. Chachapoyas: *W 7555.*

Miconia lasiostyla sp. nov. §*Amblyarrhena;* ramis obtuse tetragonis sulcatis pilis ramosis ferrugineis dense obtectis; foliis membranaceis breviter petiolatis obovato-oblongis amplis acutis ex medio ad basin obtusam cuneatis 5–7-pli-nerviis supra ad venas primarias stellatis ceterum glabris subtus dense stellato-pubescentibus; paniculis amplis ramosis dense stellato-tomentosis, floribus 5-meris subsessilibus ad apicem ramulorum glomeratis; hypanthio mediocro globoso-campanulato dense cinereo-stellato-pubescente; sepalis late rotundatis, dentibus exterioribus crasse conicis; petalis subrotundis; filamentis glandulosis inferne complanatis superne teretibus; antheris oblongis obtusis, connectivo non producto; ovario 4-loculare multiovulato summo glanduloso; stylo dense glanduloso, stigmate peltato.

Young stems obtusely 4-angled and lightly 4-sulcate, densely covered with brown branched hairs, becoming subterete and glabrous with age; petioles stout, 1–2 cm. long, pubescent like the stem; blades thin, obovate-oblong, as much as 20 cm. long by 7.5 cm. wide, acute, entire, narrowed from above the middle to an obtuse base, 5–7-pli-nerved; primaries plane above, elevated beneath, the upper arising 2–3 cm. above the base; secondaries obscure above, nearly plane beneath, arising at an angle of about 70°, about 3 mm. apart; tertiaries obsolete above, finely reticulate but nearly concealed beneath; upper surface glabrous, the primaries marked with a narrow line of short stellate hairs; lower surface densely brown-stellate-pubescent, the hairs longer and more crowded on the primaries; panicles ample, 10–15 cm. long, with usually 3 branches from the uppermost axils, the axes densely stellate-tomentose; flowers 5-merous, subsessile, densely crowded in terminal glomerules; hypanthium globose-campanulate or somewhat urceolate, 4 mm. long, densely cinereous-stellate with sessile many-branched hairs 0.3 mm. long; calyx-tube prolonged 0.3 mm.; sepals semicircular or somewhat oblong or ovate, 0.7 mm. long, 1.2 mm. wide, from narrow but rounded sinuses, membranous, nearly or quite glabrous; exterior teeth stout, conic, 0.4 mm. long, arising just above the level of the sinuses, pubescent like the hypanthium; petals subrotund, 2.5 mm. long and nearly as wide, somewhat retuse; stamens isomorphic; filaments 3 mm. long the lower four fifths stoutly flattened, the upper fifth terete and incurved, pubescent throughout, but chiefly on the basal portion, with glandular hairs 0.2 mm. long; anthers stout, oblong, 2–2.1 mm. long, with 4 cells in a single row, opening by a minute pore just under the end of the connective, which is neither prolonged nor lobed at base; ovary 4-celled. many-ovuled, its free summit convex and sparsely glandular around the style-base; style densely glandular, about 5 mm. long; stigma peltate, 1.1 mm. in diameter.

Type, *Sawada 77*, collected at Pan de Azucar, Dept. Huanuco, Peru, described as 25 ft. high, deposited in the herbarium of the Field Museum. The glandular filaments and style indicate a relationship to *M. majalis* Cogn. and *M. floribunda* (Bonpl.) DC., from which it differs in the shape

of the leaves, the character of the pubescence, and the subsessile, closely glomerulate flowers.

MICONIA PILEATA DC. Dept. San Martín: *W 6369, 6390, 7306, 7412.*

MICONIA RADULA Cogn. *Miconia sphagnophila* Macbr. Playapampa: *Macbride 4503;* Dept. Junín, Pichis Trail: *KS 25908.* A careful comparison of these two specimens with *Weberbauer 4403* and *André* (type) at Kew convinces me that the slight differences between them are of no specific significance. In the type, the hypanthial indument is composed of stout conic-incurved bristles, almost retort-shaped, their bases as much as 0.4 mm. in diameter and absolutely contiguous over the hypanthium and pedicel. In *Weberbauer 4403*, identified as this species by Cogniaux, the filaments are also glandular, but the hypanthial hairs are much more slender and proportionately longer; while they are still crowded, the actual surface of the hypanthium is generally visible between their comparatively slender bases. In *KS 25908* the hypanthium has again this indument of slender hairs but the filaments are distinctly glabrous. The presence or absence of glandular hairs on the stamens has generally been regarded of good taxonomic value and experience shows that it is seldom subject to variation or exception. Here is a case, on the other hand, where we must broaden the definition of *M. Radula* to include forms without such glands or describe a new species. If we adopt the latter alternative, we are at once faced with the disposition of the Weberbauer plant, which combines the characters of both. Under the circumstances, it seems best to include them all in *M. Radula.*

M. sphagnicola was separated from *M. Radula* because its leaves were 5-pli-nerved. I do not know whether Macbride had seen authentic material of *M. Radula* before he described his species, but infer that he had not, since the collections of André are poorly represented in America. The original collections plainly show pli-nerved leaves, and since Macbride's species has glandular filaments, it is therefore reduced to *M. Radula.*

MICONIA RUIZII Naud. Dept. Junín, Pichis Trail: *KS 25628, 25748.*

§X. *Cremanium*

Miconia aprica sp. nov. §*Cremanium*, ad *M. peruvianam* Cogn. affinis; ramis obtuse tetragonis leviter furfuraceis; foliis subcoriaceis obovato-oblongis vel ovato-oblongis 5-nerviis acuminatis basi rotundatis spinuloso-denticulatis supra scabris subtus ad venas primarias pilis ramosis obtectis ad venas secondarias sparse pilosis ad paginam glabris; paniculis ramosissimis dense stellato-pilosis, floribus 5-meris brevissime pedicellatis; hypanthio glabro rubro-punctato; sepalis triangularibus acutis, dentibus exterioribus adnatis; petalis obovatis parvis; antheris anguste obovatis 2-locellatis poro lato ventro-terminale

dehiscentibus, connectivo basi breviter producto incrassato; ovario 3-loculare multiovulato summo ad hypanthium septis 10 connexo; stylo breve crasso, stigmate truncato.

A shrub or small tree; branches stout, roundly 4-angled and shallowly sulcate when young, terete with age, glabrous below, increasingly pilose above with long branched hairs; petioles slender, 10–15 mm. long, pubescent like the stem; blades yellowish-green, subcoriaceous, obovate-oblong to ovate-oblong, 7–10 cm. long by half as wide, abruptly acuminate, rounded at base, conspicuously spinulose-denticulate, 5-nerved; primaries lightly impressed above, prominent beneath, secondaries plane above, barely prominent beneath, tertiaries obsolete above, plane and reticulate beneath, secondaries about 2 mm. apart, ascending at an angle of about 70°; upper surface scabrous with minute conical hairs; primaries freely and secondaries sparsely pilose beneath with branched hairs like those of the stem, the tertiaries and surface glabrous; panicle freely branched, 5–12 cm. long, its axes densely pilose or subtomentose with branched brown hairs; flowers subsessile, 5-merous; hypanthium broadly campanulate-hemispheric, 1.6 mm. long to the torus, glabrous, minutely and sparsely red-punctate; calyx-tube slightly spreading, 0.3 mm. wide; sepals triangular, acute, 0.5 mm. long; exterior teeth equaling the sepals in size and shape, mostly adnate; petals obovate, 1.1 mm. long, 0.8 mm. wide, rounded, symmetrical, not retuse; stamens isomorphic; filaments 3.5 mm. long, the basal two thirds widened and much thickened in the middle, the upper third slender and terete; anthers stout, narrowly obovoid, 2.5 mm. long, 2-celled, opening by a wide ventro-terminal pore; connective slightly prolonged below the pollen-sacs and somewhat elevated into a dorsal ridge; ovary half-inferior, 3-celled with numerous ovules, its free summit connected with the hypanthium wall by 10 thin radiating septa; straight, stout, glabrous, 1.6 mm. long, slightly thickened upwards to the truncate stigma.

Type, *KS 24246* collected in thickets and open woods, alt. 1800–2400 m., Huacapistana, Dept. Junín, Peru, described as a shrub 4–8 ft. high; it is in full bloom. Other specimens are *KS 24316*, from the same locality, a shrub 8–12 ft. high, in flower; *24381*, from Carpapata, above Huacapistana, alt. 2700–3200 m., a tree 15–25 ft. high, in bloom; and *22311*. from a wooded hillside at Ccarrapa, Dept. Ayacucho, alt. 2200 m., a shrub or small tree 8–12 ft. high. The latter specimen has ovate-oblong leaves and has lost most of its branched hairs. The species is related to *M. peruviana* Cogn., also from Peru, and differs in its pubescence, longer petioles, larger leaves and panicles, and glabrous hypanthium.

MICONIA CAERULEA (Don) Naud. Dept. Junín, San Ramón: *KS 24758*.

MICONIA CLATHRANTHA (Mart.) Triana. Dept. Junín, Pichis Trail: *KS 26051, 26187*.

MICONIA COELESTIS (Don) Naud. Dept. Junín, Pichis Trail: *KS 25924*.

MICONIA CYANOCARPA Naud. Dept. Junín, San Ramón: *KS 24690*.

MICONIA HYGROPHILA Naud. Dept. Ayacucho, Ccarrapa: *KS 22457;* Dept. Junín, Carpapata; *KS 24471*. The former, with leaves nearly glabrous beneath, agrees well with *Bang 722;* the latter, with leaves densely pubescent beneath, agrees equally well with *Bang 2624*. The specimens are believed to be conspecific, notwithstanding the great difference in indument.

MICONIA RAMOSIPILA Macbr. Cani: *Macbride 3411;* Tambo de Vaca: *Macbride 4341;* Muña: *Macbride 4321* (isotype).

§XI. *Chaenopleura*

Miconia Macbridei sp. nov. §*Chaenopleura;* glabra; ramis obscure 4-angulatis, mox teretibus; foliis sessilibus, coriaceis, cordato-ovatis, ad apicem obtusam acuminatis, basi cordatis, superne obscure calloso-denticulatis, 3-nerviis cum venis marginalibus adjectis; panicula parva corymbiforme ramosa, pedicellis brevibus; floribus 4-meris; hypanthio subgloboso fauce constricto; sepalis ovato-triangularibus obtusis membranaceis dentes exteriores triangulares acutos aequantibus; petalis obovatis rotundatis; staminibus desinentibus; ovario infero 4-loculare.

A glabrous shrub, the young stems obscurely 4-angled, soon becoming glabrous with the bark cracking longitudinally; leaves coriaceous, sessile, ovate, acuminate to an obtuse tip, cordate at base, 35–45 mm. long, 22–28 mm. wide, 3-nerved, with an additional pair of submarginal veins; primaries impressed above, elevated beneath; secondaries obsolete above, barely impressed below, with the tertiaries finely reticulate; panicle corymbiform, many-flowered, freely branched, 4–5 cm. long and wide; pedicels 2 mm. long; flowers 4-merous; fruiting hypanthium subglobose, 2.5 mm. long; calyx-tube minutely prolonged; sepals membranous, broadly triangular-ovate, obtuse, 0.9 mm. long; exterior teeth free, triangular, somewhat thickened at the acute apex, appressed to and just equaling the sepals; petals obovate, 2.5 mm. long, 2 mm. wide, broadly rounded at the summit, spreading; ovary wholly inferior, 4-celled: stamens and style lacking.

Type, *W 5996*, collected at Tarapoto, Dept. San Martín, Peru, alt. 750 m. Although the stamens are unfortunately lacking, the character of the inflorescence is sufficient to establish it in §*Chaenopleura*, and the 4-merous flowers and shining heart-shaped leaves show its relationship to *M. nitida* (Don) Naud., a species represented in herbaria, so far as known to me, only by the original collection of Pavon in the Herbarium Boissier at Geneva. In that species the inflorescence is few-flowered and nodding, the hypanthium and petals fully twice as large, the leaves elliptic rather than ovate and less conspicuously cordate at base, and the obvious petioles 2–4 mm. long. Cogniaux states that the calyx-lobes, by which he probably

meant the exterior teeth, are "late rotundatis"; I have not verified this point personally. It is also closely related to *M. retusa* Pilger, erroneously placed in the section *Amblyarrhena*, which has a small lax inflorescence and longer and narrower leaves.

TOCOCA Aubl.

Sect. I. *Pterophorae*

Tococa gonoptera sp. nov. §*Pterophorae;* frutex trimetralis; ramis rotunde 4-angulatis, junioribus dense longeque hirsutis; petiolis et formicariis gracilibus dense hirsutis; laminis ellipticis falcato-acuminatis crenulatis ciliatisque basi acutatis supra parce pilosis subtus ad venas majores parce setosis ceterum glabris, 3-nerviis; inflorescentia parva subumbellata terminale et in axillis superioribus; hypanthio turbinato 5-alato ad nervos inter alas setoso, alis superne ampliatis et sub apicem subito ampliatis in dentem triangularem, margine dense glanduloso-hirsutis; sepalis triangularibus acutis; petalis late obovatis vel subrotundis retusis; ovario 3-loculare circum stylum pilis discretis glandulosis ornato; stigmate lato peltato.

Stems shrubby, when young strongly 4-angled and sulcate, densely hirsute with stout, simple or minutely glandular hairs 5–7 mm. long, in age rounded 4-angled and sparsely short-hirsute; free petioles 10–15 (rarely 30) mm. long, densely hirsute; formicaria semi-ellipsoid, about 25 by 10 mm. as pressed, rather sparsely hirsute and puberulent; blades thin, bright green, narrowly elliptic, as much as 12 by 30 cm., falcately acuminate, crenulate and ciliate, acute at base, 3-nerved, with an additional pair of obscure, arcuate submarginals; veins plane above, lightly elevated beneath, the secondaries 5–8 mm. apart, arising at an angle of about 70°, the tertiaries plane and obscurely reticulate; upper surface sparsely pilose with yellow hairs 2–3 mm. long and apart; lower surface sparsely setose with similar hairs on the primaries, very sparsely setose with somewhat shorter hairs on the secondaries, and minutely and obscurely puberulent on the surface; inflorescence small, rather crowded, subumbellate, terminal and in the upper axils; hypanthium turbinate, 8 mm. long to the torus, 5-winged, densely hirsute on the margin of the wings and sparsely so on the intermediate nerves with slender glandular hairs 2.5 mm. long, elsewhere glabrous, the wings membranous, extending to the tip of the sepals, gradually widened above to 1.2 mm. and near the summit abruptly widened into a laterally projecting, triangular, acute tooth nearly 3 mm. wide; calyx-tube prolonged 2 mm. to broad but angular sinuses, very sparsely setose on the back; sepals 1.6 mm. longer, triangular, acute; petals broadly obovate or subrotund, 9 mm. long, 7 mm. wide, deeply retuse, many-nerved; filaments flat, glabrous, 1 mm. wide; anthers plump, oblong, 5–5.5 mm. long, the pore almost exactly terminal; connective elevated on the back into a low ridge and ending at base in a small obtuse protuberance; ovary wholly inferior, 3-celled, the summit rather concave, bearing at the base of the style about 50 erect,

separate, glandular setae about 0.8 mm. long; style stout, glabrous; stigma peltate, 2.7 mm. in diameter.

Type, *KS 28092*, collected in dense forest between Yurimaguas and Balsapuerto, Dept. Loreto, Peru, alt. 135–180 m. *K & S 26288*, from the same locality, and *28601*, from Balsapuerto, are the same. *T. gonocarpa* is distinguished at once by the projecting triangular tooth on the hypanthial wings.

Tococa stenoptera sp. nov. § *Pterophorae;* arbuscula; ramis vetustioribus ad nodos incrassatis glabrescentibus, junioribus valde complanatis ad marginem pilosis; petiolis crassis supra pilosis; formicariis parvis, breviter hirsutis; laminis ellipticis acuminatis minute denticulatis basi cuneatis 5-nerviis, supra setulosis subtus pubescentibus; panicula angusta axibus valde complanatis et alatis ad margines pilosis; hypanthio obconico 5-alato ad alas hirsuto, alis trans calycem productis et dentes subulatos formantibus; sepalis subtruncatis, dentibus exterioribus truncatis; petalis magnis; ovario 3-loculare semi-infero, rostro conico corona magna fimbriata ornato; stylo elongato sursum dilatato, stigmate peltato.

Small tree 5–6 m. high, the branches swollen at the nodes, with short internodes, terete and glabrous in age, when young strongly ancipitally flattened and winged, the wings densely short-hirsute on the margin, the flat sides essentially glabrous; free petiole stout, about 5 mm. long, densely hirsute on the upper side and about the base; formicaria semi-ellipsoid, 14–18 mm. long, 2-lobed, sparsely short-pubescent; blades thin, elliptic, as much as 7 by 17 cm., abruptly acuminate, minutely serrulate, cuneate at base, 5-nerved, with an additional pair of marginals; upper surface sparsely pubescent with yellowish hairs 0.6–1 mm. long and apart; lower side pubescent throughout with slender hairs 0.4 mm. long and apart and minutely glandular-puberulent on the veins; primaries and secondaries plane above, elevated beneath, the latter 3–5 mm. apart, arising at an angle of about 70°; tertiaries obscure above, somewhat elevated and coarsely reticulate beneath; inflorescence a terminal panicle 18 cm. long, its axes strongly flattened and winged, very minutely glandular-puberulent on the sides, sparsely pilose on the wings with rather crooked hairs 0.5–0.8 mm. long, the lateral branches 10–7 mm. long, decreasing above, each bearing a sessile terminal flower and 2 stout, 4-winged pedicels 8–3 mm. long, each with a terminal flower; bracts filiform, 1–1.5 mm. long; flowers 5-merous; hypanthium campanulate-obconic, 7.5 mm. long to the torus, minutely puberulent with reddish hairs, 5-winged, the wings thick and fleshy, 0.5 mm. wide, opposite the sepals, densely hirsute, continuing across the calyx and projecting 1–1.3 mm. beyond it as subulate teeth; calyx-tube prolonged 1.4 mm. to the sinuses, the sepals broadly depressed-rounded, only 0.5 mm. long; external teeth truncate, villous along the margin; petals pink, obovate-oblong, slightly inequilateral, 11.5 mm. long, 5–6 mm. wide, deeply retuse, obscurely

5-nerved; filaments flattened, 7.7 mm. long; anthers stoutly linear, 7.5 mm. long, slightly incurved at the tip, opening by a terminal pore; connective elevated into a conspicuous ridge on the back, with a basal protuberance; ovary half-inferior, 3-celled, its free summit conic-ovoid, 1.6 mm. long, surmounted by a somewhat flaring corona 3.2 mm. long with a fimbriate margin; style glabrous, 18 mm. long, gradually enlarged above; stigma peltate, 3 mm. in diameter.

Type, *KS 26280*, collected at Puerto Yessup, Dept. Junín, Peru, in dense forest at 400 m. alt. Among the few species of the section with winged hypanthia, only *T. pauciflora* Spruce shows the wings projecting conspicuously beyond the margin of the calyx; it differs from ours in its few-flowered infloresence with very slender axis.

TOCOCA STEPHANOTRICHA Naud. I have not seen the type of the species, collected by Poeppig at Maynas Alto. *Spruce 4256*, referred here by Cogniaux, is from Tarapoto, in the same general region, and presumably is conspecific. We have one specimen, *KS 25967*, collected on the Pichis Trail at 1100 m. which agrees precisely in vegetative characters with Spruce's plant, and a second, *KS 26035*, from the same locality, which is conspecific with the first but has larger and thinner leaves. This variation might be expected, since the first grew in thickets and the last in dense forest. Flowers of the Spruce plant have not been dissected by me. In comparison with the detailed description of the species by Cogniaux, our plants agree in all matters of form and dimensions except in three points, the ovary is 3-celled instead of 5-celled; its corona is erect and the hypanthial wings are narrowed to an acute angle at the summit, while Cogniaux' plate indicates a spreading corona and hypanthial wings truncate at the top. Our specimens are accordingly referred to this species with some hesitation.

Tococa temnoptera sp. nov. Ad *T. stephanotricham* arcte affinis sed recedit caule 4-angulato, formicariis gracilioribus, foliorum laminis majoribus pro rata angustioribus longiore acuminatis basi acutioribus, hypanthii alis superne truncatis vel margine exteriore paullum productis, petalis subduplo majoribus, ovarii corona horizontaliter patula fimbriata.

Stems shrubby, even in age roundly 4-angled and shallowly sulcate, when young densely hirsute with both simple and glandular hairs 5–6 mm. long; free petioles 15–20 mm. long, glandular-hirsute; formicaria slender, 3 cm. long, 6 mm. wide when pressed, hirsute; blades thin, elliptic, as much as 19 by 12 cm., sharply acuminate, nearly entire, broadly acute or cuneate at base, 5-nerved, the veins all plane above, lightly elevated beneath; upper surface freely hirsute with yellow hairs about 2 mm. long and 1 mm. apart, also minutely puberulent with very short hairs 0.2 mm. apart; lower surface setose

on the principal veins and occasionally on the tertiaries with slender hairs 1–2 mm. long, also sparsely puberulent on the surface with minute hairs less than 0.1 mm. long; inflorescence a few-flowered panicle 6 cm. long, its axis sparsely setose and densely puberulent, the 5-merous flowers nearly sessile; hypanthium obconic, 7.5 mm. long, 5-winged with 5 intermediate nerves, densely hirsute on the nerves and wings with bluish glandular hairs 2 mm. long; wings 1.5 mm. wide, continuing into the midnerve of the sepals, their tips very densely hirsute, truncate or triangular and somewhat projecting; calyx-tube prolonged 2.3 mm. to rounded sinuses; sepals ovate-triangular, 2.2 mm. long, obtuse, glandular-hirsute and densely glandular-ciliate; petals pale pink to white, obovate-oblong, 16 mm. long, 8.5 mm. wide, deeply cordate-retuse, conspicuously many-nerved; filaments flat, 7.5 mm. long; anthers stoutly linear, 6 mm. long, the connective elevated into a low dorsal ridge bearing a minute basal protuberance; ovary almost wholly inferior, 3-celled, the free tip conic, very short, surmounted by a horizontal, fimbriate-ciliate corona 4 mm. in diameter; stigma peltate.

Type, *KS 26237*, collected at Puerto Yessup, Dept. Junín, Peru, alt. 400 m., in dense forest. In comparison with *T. stephanotricha* it has glandular stems, more slender formicaria, larger and proportionately narrower leaves, which are longer acuminate, more tapering at base, and less pubescent, much larger flowers, hypanthial wings truncate above, and a spreading corona on the ovary.

Sect. II. *Hypophysca*

TOCOCA BULLIFERA Schr. & Mart. Manáos: *KS 30133*.

TOCOCA GUIANENSIS Aubl. Dept. Loreto: *KS 26974, 27292, 27348, 29763, 29877, 29883, 29996, W 1301, 1711, 3175, 3657, K 415;* Manáos: *KS 30063*. While the original locality of this species is French Guiana, herbaria usually contain a large series of specimens referred to it and ranging from Guiana to Panama, or even Central America, and throughout the Amazonian lowlands as far as Bolivia. This is an enormous range for any one species, and at once suggests the advisability of a critical examination of its homogeneity. Even the most superficial inspection shows that it covers plants with a wide range of structure, several of which will probably need to be segregated.

Nine of the specimens cited above exhibit flowers and have been carefully dissected, with rather surprising results. The chief points of difference among them lie first, in the shape and pubescence of the sepals and exterior teeth, and second, in the structure of the ovarian corona. According to the first, they may be divided as follows:

Exterior teeth triangular, conspicuously projecting beyond the sepals, bearing few or several setae.
- Setae 8–12, 2–2.5 mm. long, glandular (type A) . . . . . . *1301, 29883.*
- Setae about 3, never more than 0.8 mm. long, glandular (type B) . . . . . . *30063.*

Exterior teeth broadly depressed-rotund, not projecting or scarcely so.
- Exterior teeth with several short setae (type C) . . . . . . *415, 27348, 29996.*
- Exterior teeth each with a single short seta (type D) . . . *3657, 26974, 27292, 29877.*

According to the structure of the corona:

Corona not developed (type 1) . . . . . . *29877.*

Corona tubular, connate.
- Corona bearing at the summit about 10 short, oblong, densely glandular-pubescent lobes (type 2) . . . . . . *415.*
- Corona bearing about 10 glandular bristles from triangular bases (type 3) . . . . . . *1301, 3657, 27292, 27348, 29883, 29996, 30063.*

Corona of numerous distinct bristles as much as 5 mm. long (type 4) . . . . . . *26974.*

This gives us four types of structure in the calyx and four in the corona. If we try to correlate them with each other, we have the following results:

Type A with type 3 . . . . . . *1301, 29883.*
Type B with type 3 . . . . . . *30063.*
Type C with type 2 . . . . . . *415.*
Type C with type 3 . . . . . . *27348, 29996.*
Type D with type 1 . . . . . . *29877.*
Type D with type 3 . . . . . . *3657, 27292.*
Type D with type 4 . . . . . . *26974.*

Tococa loretensis Ule is of type C and type 3; *T. discolor* Pilger is of type D and type 2. The former differs from our plants of similar type in having a racemose inflorescence and merely puberulent hypanthium, while ours are paniculate with setose hypanthium. We have then apparently nine groups of recognizable forms, two of which have been, and all of which might be described as species, especially since most of them are further distinguished by other floral and vegetative characters. I believe personally that they should not be so described unless a careful examination of the whole group to which they belong justifies the action, and I accordingly refer them all temporarily to Aublet's species.

TOCOCA JURUENSIS Pilger. Dept. Loreto, Pebas: *W 1617, 1685, 1940.*

TOCOCA MICRANTHA Ule. Dept. Junín, Puerto Bermudez: *KS 26482;* Dept. Loreto, Soledad: *KS 29706, 29715.*

TOCOCA PARVIFLORA Spruce. Dept. Loreto, Balsapuerto: *KS 28511.*

TOCOCA ULEI Pilger. Dept. Loreto, Caballo-cocha: *W 2050, 2101.*

TOCOCA sp. Dept. Loreto: *KS 29763, W 1711, 3175.*

Sect. III. *Epiphysca*

TOCOCA CAPITATA Traill. Dept. Loreto, Iquitos: *KS 27434.*

TOCOCA EGENSIS Naud. Dept. Loreto, near mouth of Rio Tigre: *KS 27535*, Iquitos: *W 8036*.

Tococa glandulosa sp. nov. §*Epiphysca;* frutex bimetralis; ramis rotunde 4-angulatis praeter nodos setulosos glabris; petiolis elongatis minute furfuraceis; laminis ovato-lanceolatis, ad basin majorum vesiciferis, acuminatis basi rotundatis 5-nerviis supra glabris subtus minute furfuraceis praecipue ad nervos; inflorescentia ampla paniculata ad nodos inferiores setulosa superiores glandulosa; hypanthio obconico dense glanduloso-hirsuto; calycis tubo suberecto breve; sepalis semicircularibus; dentibus exterioribus late triangularibus glandulosis a medio subulato-acuminatis sepala paullo excedentibus; petalis obovato-oblongis; antheris superne inflexis inferne in lobos 2 rotundatos productis; connectivo dorso elevato et basi minute calcarato; ovario semiinfero, superne conico truncato pilis glanduliferis longitudine variis coronato; stylo elongato glanduloso-pilosulo.

Flowering branches conspicuously but roundly 4-angled, the internodes about 6 cm. long and glabrous, the nodes somewhat swollen, marked with a setulose stipular ring and often subtomentose in the axils; petioles rather stout, 12–15 mm. long, minutely furfuraceous, especially above; leaves slightly unequal in each pair, firm, ovate-lanceolate, 15–20 cm. long, 6–7.5 cm. wide, long-acuminate and mucronate, rounded or somewhat subcordate at base, 5-nerved, glabrous above, minutely furfuraceous beneath, especially along the nerves; secondary veins arising at right angles to the midvein, about 3 mm. apart; formicaria on only the larger leaves, ovoid, 2 cm. long; panicle rather slender, 20 cm. long, the lateral branches flattened, the principal axes essentially glabrous on the internodes, setulose and subtomentose at the nodes, the smaller branches glandular-hirsute; flowers sessile; hypanthium obconic, 8 mm. long, with leathery walls, very minutely and sparsely stellate, freely glandular-hirsute with hairs 1.5–2 mm. long; calyx-tube nearly erect, prolonged 0.9 mm.; sepals depressed-triangular from broadly rounded sinuses, 0.7 mm. long; exterior teeth continuous, broadly triangular, slightly shorter than the sepals, hirsute like the hypanthium, at the center thickened and prolonged into a subulate tooth 0.7 mm. long; petals lilac-rose, obovate-oblong, 10 mm. long; filaments flat, 6 mm. long; anthers stoutly linear, about 7 mm. long, inflexed above to a terminal pore, prolonged at base into 2 rounded lobes; connective elevated into a prominent dorsal ridge bearing a conspicuous tubercle at base; ovary mostly inferior, 3-celled, the short free beak 10-ribbed, each rib continued into an erect glandular seta 0.5–3.5 mm. long; style 19 mm. long, glandular-pubescent; stigma capitate, 1.7 mm. in diameter.

Type *K 424*, collected at Mishuyacu, near Iquitos, Dept. Loreto, Peru. It is a member of a small group of species placed at present partly in *Epiphysca* and partly in *Anaphysca* and including *T. coronata*, *T. truncata*, *T.*

lasiostyla, and *T. setifera*, from all of which it differs in its glandular-hirsute hypanthium. In vegetative characters it particularly resembles *T. lasiostyla*, which differs also in several points of floral structure.

TOCOCA LASIOSTYLA Cogn. Dept. Loreto: *KS 27426*, *W 3119*, *K 744*.

MAIETA Aubl.

MAIETA GUIANENSIS Aubl. Dept. Junín: *KS 26151*, *26544*, *26551*, *26779*; Dept. Loreto: *KS 28407*, *29509*, *29760*, *29983*, *W 947*, *1069*, *1623*, *2351*, *2563*, *2718*.

MAIETA POEPPIGII Mart. Dept. Junín: *KS 26432*; Dept. Loreto: *W 1169*, *1239*, *1571*, *1689*, *2545*, *2717*.

CLIDEMIA Don

CLIDEMIA AFFINIS (Naud.) Cogn. Dept. Loreto: *KS 28175*, *W 749*, *751*, *771*, *800*, *1900*, *3844*.

CLIDEMIA BULLOSA (Spreng.) Cogn. Pará: *Dahlgren & Sella 745*.

CLIDEMIA CILIATA Don. Dept. Ayacucho, Aina: *KS 22704*.

CLIDEMIA CORDATA Cogn. Dept. Junín, Puerto Yessup: *KS 26340*; Dept. Loreto, La Victoria: *W 2709*.

CLIDEMIA DENTATA Don. Dept. Ayacucho: *KS 22921*, *23082*; Dept. Junín: *KS 26269*, *26403*, *26440*; Dept. Loreto: *W 750*, *774*, *793*, *795*, *1275*, *1293*, *1596*, *1694*, *2040*, *KS 28625*. This common Amazonian species appears to be common and widely distributed over the lowlands of eastern Peru. Of the numerous specimens available, *KS 22921* differs strongly from the others in certain vegetative characters. The upper parts of the stem, the petioles and young leaves, the inflorescence, and the hypanthium are hirsute with bright purple-red hairs, while the leaves are considerably larger, thinner, and much more sparsely pubescent with shorter hairs than the usual form. The combination of these characters gives it a facies quite unlike the usual appearance of the species, but all the characters of flower-structure are precisely the same.

CLIDEMIA DEPENDENS Don. Dept. Junín: *KS 23978*; Dept. Loreto: *KS 27205*, *W 1461*, *K 334*, *1244*; Pará: *KS 30557*.

CLIDEMIA DISPAR (Triana) Cogn. Two fruiting specimens from Dept. Loreta, *KS 28443* and *28591*, resembling the usual form of the species in general habit but with much larger, coarsely dentate leaves as much as 14 cm. long, have been referred here but may prove to be distinct.

CLIDEMIA EPIBATERIUM DC. Dept. Loreto, near Iquitos: *KS 29885*; on the Río Itaya: *KS 29516*, *29623*. The first sheet cited is a very pubescent plant, but with petioles of the average length. The last two are smoother and the leaves are almost sessile.

CLIDEMIA FOLIOSA Gl. Dept. Loreto: *W 933*, *1058*

CLIDEMIA HETEROPHYLLA (Desr.) Gl. Dept. Junín: *KS 26744;* Dept. Loreto: *KS 28482, 28575.*

CLIDEMIA HIRTA (L.) Don. Dept. Junín: *KS 23983, 26192;* Dept. San Martín: *W 6337, 7514;* Dept. Loreto: *KS 24217, 26839, 26900, 26966, 27072, 29381, 29505, W 269, 1318, 1480, 1972, 2776, K 68;* near Pará: *KS 30298, 30390, Williams & Sella 1.*

CLIDEMIA JAPURENSIS DC. Dept. Loreta, Pebas: *W 1701.*

CLIDEMIA JURUENSIS (Pilger) Gl. Dept. Loreta, Santa Rosa: *KS 28754.*

Clidemia longifolia sp. nov. § *Sagraea;* caulibus sublignosis scandentibus inter nodos radicantibus teretibus gracilibus glabris; petiolis elongatis crassis dense hirsutis; laminis magnis oblongis acuminatis irregulariter dentatis ciliatisque basi rotundatis 5-nerviis supra glabris subtus ad venam mediam pilosis ad venulas minutissime furfuraceis ceterum glabris; inflorescentia paniculata; hypanthio subgloboso dense hirsuto; sepalis glabris triangularibus, dentibus exterioribus foliaceis oblongis patulis hypanthium aequantibus; ovario 4-loculare.

Stems climbing, rooting between the nodes, slender, terete, glabrous, with elongate internodes; petioles stout, 25–50 mm. long, densely hirsute with spreading or mostly reflexed hairs as much as 3 mm. long; blades probably unequal in each pair, thin, oblong-lanceolate, as much as 45 cm. long by 11 cm. wide, acuminate, subrotund at base, irregularly and shallowly toothed, sparsely ciliate, 5-nerved, the outer pair extending only half the length of the leaf and with a pair of additional marginal veins extending only a few centimeters, veins plane above, lightly elevated and prominently reticulate beneath, the secondaries 6–10 mm. apart, arising at an angle of about 75°, and nearly straight; upper surface glabrous; lower side glabrous on the actual surface when mature, pubescent when young, very minutely furfuraceous or pubescent on the smaller veins, freely pilose on the midvein with spreading or reflexed hairs 1.5 mm. long; inflorescence a small axillary panicle 3 cm. long with slender furfuraceous branches; pedicels 2–4 mm. long; flowers 4-merous; hypanthium subglobose, 3.2 mm. long, densely hirsute; calyx-tube spreading horizontally, 0.3 mm. wide; sepals depressed-triangular, 0.7 mm. long, glabrous; exterior teeth spreading, foliaceous, oblong-lanceolate, 3.2 mm. long, acuminate, essentially glabrous, adnate to the sepals almost to their tips; petals and stamens not displayed; ovary wholly inferior, 4-celled, its rounded summit glabrous; seeds very numerous, rounded-obconic; style not seen.

Type *K 62*, collected in dense forest at Mishuyacu, near Iquitos, Dept. Loreto, Peru, alt. about 100 m. Other specimens from the same locality are *K 554* and *KS 29948*. It is clearly a member of §*Sagraea* and related to *C. epiphytica* (Triana) Cogn., from which it differs in its smooth stems, much narrower leaves, stouter petioles, and glabrous exterior calyx-lobes.

CLIDEMIA NAEVULA (Naud.) Triana. Dept. Loreto: *KS 26927, 26967, 29670, W 792, 796, 962, 1035, 1178, 2039, 2121, 2123, 2184, K 576.*

Clidemia peruviana sp. nov. §*Sagraea;* caulibus fruticosis gracilibus subteretibus glabris parce ramosis; petiolis gracilibus puberulentibus; laminis membranaceis oblongis abrupte caudato-acuminatis minutissime ciliatis basi late cuneatis insigniter 5-pli-nerviis, supra juventute sparse puberulis glabrescentibus venis primariis persistenter pubescentibus, subtus glabris arcte reticulatis; floribus paucis sessilibus in axillis superioribus fasciculatis 4-meris; hypanthio tubuloso minutissime puberulo; sepalis patulis membranaceis late triangularibus ad dentes exteriores oblongos foliaceos tenuissime pubescentes adnatis et multo brevioribus; petalis erectis ovato-lanceolatis apice cucullatis sub apicem breviter setosis; antheris crasse linearibus 4-locularibus, connectivo non producto; ovario 3-loculare superne umbonato; stylo gracile, stigmate capitato.

A slender shrub 10–18 dm. high, the stems above slender, subterete, somewhat swollen at the nodes, glabrous or very sparsely puberulent when young; petioles slender, 12–18 mm. long, conspicuously puberulent; blades very thin, oblong, 8–12 cm. long, 3–5 cm. wide, abruptly caudate-acuminate, entire, minutely ciliate, broadly cuneate at base, 5-pli-nerved, the uppermost laterals arising 1–2 cm. above the base; primaries plane above, lightly elevated beneath, secondaries straight, 2–3 mm. apart, arising at an angle of about 75°, plane above and beneath, the tertiaries very finely reticulate; upper surface very sparsely puberulent when young, soon glabrous, the primaries persistently pubescent; lower surface glabrous; flowers 4-merous, about 5, sessile in the upper axils; hypanthium tubular-obconic, 2.4 mm. long to the torus, very minutely puberulent; calyx-tube prolonged about 0.3 mm., very thin and delicate or scarious, the sepals of the same texture, 0.2 mm. long, depressed-triangular, almost wholly adnate to the oblong, foliaceous, minutely aristate, puberulent exterior teeth, which are erect and 1 mm. long; petals erect, subscarious, ovate-lanceolate, 1-nerved, 2.5 mm. long, cucullate at the apex and short-setose just below it on the back; filaments flat, scarious, 1-nerved, 2.5–2.8 mm. long, somewhat incurved and abruptly narrowed near the summit; anthers stoutly linear, 2.2 mm. long, 4-celled, the connective neither prolonged nor appendaged; ovary wholly inferior, 3-celled, the glabrous summit umbonate at the center; style slender, 6.5 mm. long, scarcely tapering upward to the small capitate stigma.

Type, *KS 25411,* collected near La Merced, Dept. Junín, Peru, in dense forest, alt. 800–1300 m. Its nearest relative is *C. sessiliflora* (Naud.) Cogn., of the same general region, from which it differs in the cuneate leaf-base, the conspicuously pubescent primaries, and the much smaller petals.

Clidemia procumbens sp. nov. § *Sagraea;* caulibus humilibus herbaceis vel sublignosis basi procumbentibus superne foliatis, junioribus minutissime fur-

furaceis obtuse 4-angulatis mox teretibus glabrescentibus; foliis magnis ovatis, late oblongis vel obovatis acuminatis, basi obtusis, rotundatis, vel subcordatis, obscure denticulatis ciliatisque 5-nerviis; inflorescentia solitaria subterminale ampla ramosa sparse glanduloso-pilosa, floribus sessilibus; hypanthio urceolato sparsissime glanduloso-piloso; sepalibus triangulari-ovatis.

Stems procumbent and rooting at base, herbaceous or somewhat woody, the erect portion ultimately 5–10 cm. high, leafy only above, younger portions very thinly brown-furfuraceous and obtuse 4-angled, soon becoming glabrous and terete; petioles stout, 5–18 cm. long, essentially glabrous; blades thin, ovate, broadly oblong, or more usually somewhat obovate, 20–25 cm. long by 12–15 cm. wide, or occasionally as much as 30 cm. long, the smaller members of each pair about two thirds as large as the others, abruptly short-acuminate, obscurely denticulate and evanescently ciliate, obtuse to rounded or subcordate at base, 5-nerved, glabrous throughout or minutely furfuraceous on the veins beneath; veins plane above, lightly elevated beneath, the secondaries 6–10 mm. apart, the tertiaries reticulate; panicle solitary from an upper axil, freely branched, 10–15 cm. long, its branches very sparsely glandular-pilose; flowers sessile, 4-merous; hypanthium urceolate, very sparsely glandular-pilose, toral scales none; calyx-tube not prolonged, the glabrous sepals triangular-ovate, 1 mm. long; petals and stamens not seen; ovary wholly inferior, its summit glabrous; fruit blue, globose, lightly 8-sulcate, 5 mm. in diameter.

Type, *KS 28852*, collected at Santa Rosa, on the lower Río Huallaga below Yurimaguas, Dept. Loreto, Peru, in dense forest at an altitude of about 135 m. Other specimens from the same collectors are *28423*, *28473*, *28479*, *29567*, and *29729*, all from similar altitudes in Loreto, and *26659* and *26734* from low altitudes in Dept. Junín. In four of these eight specimens the branches of the inflorescence are described as rich pink; the fruit has been noted as some shade of blue in six of them and as pink in one. All are in fruit except *28423*, which shows immature buds and was described as having red sepals. The amount of glandular pubescence varies considerably, reaching its maximum in *26734* ,where it is conspicuous without close scrutiny. The selection of a type has been wholly arbitrary and the one chosen is noteworthy for its unusually large leaves.

Clidemia procumbens is undoubtedly related to a group of little known species including *C. epiphytica* Cogn., *serpens* Cogn., *crotonifolia* Pilger, *radicans* Pilger, and *urticoides* Pilger. Of these the first two are climbers or epiphytes, with distinctly elongate stems, while in the last three the panicles are very small and compact. The habit of our plant is itself sufficient to distinguish it immediately from all its relatives.

CLIDEMIA RADICANS Pilger. Dept. Loreto, Soledad: *KS 29764*.

CLIDEMIA RUBRA (Aubl.) Mart. Dept. San Martín: *W 6359*, *7644*; Dept. Loreto: *KS 29213*, *W 5375*.

CLIDEMIA SEPTUPLINERVIA Cogn. Dept. Junín: *KS 26481;* Dept. Loreto: *KS 28346, 29449, 29641, W 3375, 4555.*

CLIDEMIA SESSILIFLORA (Naud.) Cogn. Dept. Junín: *KS 24699, 25500, 25648.*

CLIDEMIA STRIGILLOSA (Sw.) DC. Manáos: *KS 30180.*

CLIDEMIA TESTICULATA (Triana) Gl. Dept. Junín, Dos de Mayo: *KS 25798.*

CLIDEMIA TILAEFOLIA DC. Dept. San Martín: *W 6332;* Dept. Loreto: *W 3216, 4007, 4168, 4839, 7854.*

CLIDEMIA ULEI Pilger. Dept. Loreto, near Iquitos: *KS 26949, 27081, 27207, 27475.*

BELLUCIA Neck.

BELLUCIA GROSSULARIOIDES (L.) Triana. Dept. Junín: *KS 24626;* Dept. Loreto: *KS 27978, 29215, W 643, 1588, 2073;* Pará: *Dahlgren & Sella 536.* The whole genus *Bellucia,* although containing scarcely more than a dozen described species, is sadly in need of careful study. The specimens cited have been referred tentatively to this species, pending more exact knowledge of some of the other species reported from the upper Amazon.

Bellucia umbellata sp. nov. Arbor parva; hornotinis superne 4-angulatis et complanatis, dense strigoso-tomentellis, internodis brevibus; petiolis gracilibus; foliorum laminis membranaceis fragilibus oblongis amplis acuminatis integris basi rotundatis 5-pli-nerviis, supra glabris praeter venis primariis sparse strigosis, subtus sparse puberulentibus, venis subtus crasse reticulatis elevatis; inflorescentia umbelliforme pedunculata sub-20-flora furfuracea; floribus pedicellatis 5-meris; hypanthio subhemisphaerico furfuraceo; calycis lobis brevissimis; petalis ovato-triangularibus brevibus subacutis, ad faciem superiorem ultra mediam lobos 3 tumidos deflexos gerentibus; staminibus 10, isomorphis; filamentis complanatis; antheris oblongis obtusis poris 2 terminalibus dehiscentibus; ovario infero 5-loculare; stylo elongato; stigmate capitato.

A tree 5–9 m. high, the tips of the branches 4-angled and flattened, with very short internodes, and densely brown-tomentulose with straight short appressed hairs; petioles slender, 2–3 cm. long, pubescent like the stem; leaf-blades very thin, frequently shattering into fragments upon drying, oblong-ovate to oblong-obovate, usually somewhat unequal in each pair, as much as 30 cm. long by 15 cm. wide, sharply acuminate, entire, rounded at base, 5-plinerved, minutely strigose on the primaries above, very sparsely puberulent beneath; veins all lightly impressed above, strongly elevated and conspicuously and coarsely reticulate beneath, the secondaries 8–10 mm. apart, ascending at an angle of about 75°, the upper primaries arising 4–7 cm. above the base and often alternate; inflorescence apparently from corky protuberances

on the old wood, umbellate, minutely furfuraceous; peduncle 1.5–2 cm. long; flowers about 20, 5-merous, on pedicels about 1 cm. long; hypanthium subhemispheric, 4.6 mm. long to the torus, broadly rounded at base, minutely furfuraceous; calyx-tube prolonged 0.4 mm.; sepals very broadly depressed, about 0.2 mm. long and 3 mm. wide; petals triangular from a broad base, 5.5 mm. long, 4.7 mm. wide just above the base, subacute, the distal third somewhat swollen and bearing at its base on the inner side a large ovoid central lobe and two lanceolate lateral lobes, all deflexed and about 1 mm. long; stamens 10, isomorphic; filaments glabrous, flattened, 5.5 mm. long; anthers stoutly oblong, 5.5 mm. long, obtuse at both ends, 4-celled, opening by 2 minute terminal pores, the thecae prolonged about 1 mm. below the dorsal insertion of the filament; connective stout, somewhat elevated along the back but neither appendaged nor prolonged; ovary small, wholly inferior, 5-celled with very numerous ovules; style straight, glabrous, stout, 16 mm. long; stigma capitate, 1.5 mm. in diameter.

Type *K 131*, collected at Mishuyacu, near Iquitos, Dept. Loreto, Peru. Other specimens from the same locality are *K 19* and *701*, in flower, and *859*, with young fruit.

The species is at once distinguished from all known species of *Bellucia* and *Loreya* by the shape, size, and appendages of its petals. In leaf-form it approaches *L. Spruceana* Benth., in which the large calyx is regularly 5-lobed with large triangular sepals.

The genera *Bellucia* and *Loreya* are not sharply distinguished, and the assignment of this species to one genus or the other is somewhat arbitrary. It has the large leaves and 2-pored anthers of *Bellucia*, the small 5-merous flowers of *Loreya*, and the petals of neither. Since 5-merous flowers are known in at least two species of the former, more weight has been given to the structure of the anthers and the plant has been assigned to that genus.

Bellucia Weberbaueri Cogn. Dept. San Martín, Alto Río Huallaga: *W 5591;* Dept. Loreto, lower Río Huallaga: *W 3969*, *7828*, near Iquitos: *KS 26898*.

Loreya DC.

Loreya Spruceana Benth. I have referred *KS 27455* to this species with some hesitation. In the type, *Spruce 1249*, from Manáos, the leaves are more rounded at the base, the uppermost pair of lateral veins arise only 1–2 cm. from the base, the secondaries are prominently elevated beneath and 5–6 mm. apart, and the hypanthium is furfuraceous only without. In our plant, collected at Iquitos, nearly a thousand miles west of Manáos, the leaves are rather distinctly cuneate at base, the upper laterals

arise 7 cm. from the base, the secondaries are lightly elevated and 8–10 mm. apart, and the calyx-tube is furfuraceous also within.

Henriettea DC.

Henriettea maroniensis Sagot was for many years known only by the original collection of Melinon in French Guiana, until Ule rediscovered it at Surumu in extreme northern Brazil. *KS 30170*, from Manáos, comes nearer to this species than any other, and it is accepted as this species tentatively. In the original, the hairs of the lower leaf-surface are distinctly stellate, forming a silvery tomentulose indument, and many of them end in a perfectly straight, erect seta 0.3–0.5 mm. long; the hypanthium is strigose. In the Manáos plant, the hairs on the lower leaf-surface are plumose rather than stellate, all ending in a very slender bristle, making the leaf softly pubescent; the hypanthium is hirsute rather than strigose. Our plant is distinctly not *H. horridula* Pilger, collected at Manáos by Ule, in which the hairs of the lower leaf-surface are stellate, not overlapping, and with a terminal bristle 2 mm. long, while the hairs on the hypanthium are much shorter, fewer, and heavily papillose.

Henriettea stellaris Berg. Dept. Loreto: *W 619*, *K 746;* Manáos: *KS 30065*.

Henriettea succosa (Aubl.) DC. Pará: *KS 30286*.

Henriettella Naud.

Henriettella verrucosa Triana. Dept. San Martín: *W 6392;* Dept. Loreto: *W 1717, 1736, 1864, 2091, 2972.*

Ossaea DC.

Ossaea boliviensis (Cogn.) comb. nov. *Clidemia boliviensis* Cogn. Bull. Torrey Club **17:** 94. 1890. Dept. Junín: *KS 26250, 26486, 26535;* Dept. San Martín: *W 6572;* Dept. Loreto: *KS 28338. W 1730, 3905.* Cogniaux in his original description did not mention the petals, since the plant seems to be entirely in fruit. He overlooked one or two hidden behind the sepals, which are lanceolate, long-acuminate, and with a number of hirsute bristles in the upper part. Recent collections show the structure much better: the petals are narrowly lanceolate, 1.1 mm. wide near the base, tapering thence to the apex, and 5.5 mm. long. Somewhat below the tip the membranous sides are slightly cucullate, while only the midvein is carried on to the apex, after the fashion of the external calyx-teeth which are typical of so many melastomes. The back of the petal is sparsely hirsute with straight hairs as much as 1 mm. long, and the apex above the cuculla bears several stouter hairs as much as 3.5 mm. long. The petals are quite unlike those of

Clidemia, in which they are regularly obtuse, while the cucullate structure and prolonged midvein are characteristic of *Ossaea*, to which genus the species is therefore transferred.

Ossaea bullifera (Pilger) comb. nov. *Leandra bullifera* Pilger, Verh. Bot. Ver. Brand. **47**: 169. 1905. Dept. Loreto, La Victoria: *W 3139*. The axillary fascicles of flowers, the structure of the flower, and the general aspect of the plant are all typical of *Ossaea* rather than *Leandra*.

OSSAEA CAPILLARIS (Pav.) Cogn. Dept. Junín: *KS 25318*.

Ossaea cucullata sp. nov. Fruticosa; ramis subteretibus dense furfuraceis; petiolis brevibus gracilibus dorso furfuraceis supra tomentosis; laminis membranaceis ovato-lanceolatis longe acuminatis basi obtusis integris 5-pli-nerviis supra glabris subtus minutissime furfuraceis; cymis lateralibus multifloris furfuraceis; floribus 5-meris; hypanthio cylindrico villoso et furfuraceo; sepalis brevissimis a dentibus exterioribus conicis vix superatis; petalis lanceolatis dorso furfuraceis superne involutis ad apicem cucullatam dente exteriore ovato paullum superatam; ovario 4-loculare summo villoso; stylo elongato glabro, stigmate truncato.

Branches subterete, closely brown-furfuraceous; petioles slender, 8–15 mm. long, furfuraceous below, tomentose above; blades thin, bright green, ovate-lanceolate, as much as 12 cm. long by 5 cm. wide, sharply long-acuminate, broadly obtuse and often inequilateral at base, entire, 5-pli-nerved, the laterals arising somewhat alternately; upper surface tomentulose on the midvein, otherwise glabrous, the secondaries arising at an angle of about 80°, all veins lightly impressed and finely and conspicuously reticulate; lower surface furfuraceous on the primaries, otherwise glabrous, the secondaries sharply elevated, the tertiaries plane and finely reticulate; cymes lateral, 2–4 cm. long, many-flowered, thinly furfuraceous, minutely bracteolate at the nodes; pedicels 2–4 mm. long; flowers 5-merous; hypanthium cylindric-urceolate, 2.5 mm. long to the torus, obscurely 10-ribbed, softly villous with simple hairs 0.5 mm. long; calyx-tube very short; sepals sub-semicircular, hyaline, 0.3 mm. long, barely exceeded by the stoutly conic, villous exterior teeth; petals narrowly lanceolate, somewhat inflexed, 3.5 mm. long, densely furfuraceous and sparsely pilose on the back, the hyaline sides involute above to a cucullate apex surmounted by an ovate or triangular external tooth; stamens isomorphic; filaments thin and flat, 1.7 mm. long; anthers linear, obtuse, 2 mm. long, opening by a fairly wide terminal pore; connective neither appendaged nor prolonged; ovary almost wholly superior, 4-celled, villous at the summit; style slender, glabrous, 6 mm. long; stigma truncate.

Type *K 518*, collected at Mishuyacu, near Iquitos, Dept. Loreto, Peru; it is described as a shrub 1.5 m. high, with white and dark lilac flowers. Other specimens from the same locality are *K 1116*, a shrub 1 m. high with white flowers, and *KS 29949*, a slender shrub 4–5 ft. high; also

from the lower Río Huallaga, Dept. Loreto: *W 4849*, *1235*, *KS 28756*. Klug's second collection shows that the fruit is globose, 3 mm. long, and villous. The structure of the fruit and the 5-merous flowers show that it is of the section *Glaziophytum* Cogn. and apparently related to *O. capillaris* (D. Don) Cogn. It differs from that species in its larger and broader, almost glabrous leaves, its many-flowered, furfuraceous inflorescence, its lack of glandular hairs on the hypanthium, and its shorter exterior teeth. The petals of *O. capillaris* have not been examined. In leaf-form, even to the finer details of venation, our species is almost precisely like *Clidemia naevula* (Naud.) Triana.

OSSAEA MICRANTHA (Sw.) Macf. Dept. Junín: *KS 25974*, *26425*, *26503;* Dept. Loreto: *W 3465*.

MYRIASPORA DC.

MYRIASPORA EGENSIS DC. Dept. Loreto: *W 2704;* Pará: *KS 30287*, *30315*, *30430*, *30488*.

BLAKEA P. BR.

BLAKEA CHANCHAMAYENSIS Macbr. Dept. Junín, San Ramón: *Macbride 5676*, *Schunke A 119*, *KS 24620*.

BLAKEA OVALIS Don. Dept. Loreto, near Iquitos: *K 391*.

Blakea paludosa sp. nov. Arbor; ramis juvenilibus dense ferrugineo-tomentosis mox subglabratis; petiolis crassis brevibus tomentulosis; foliorum laminis coriaceis opacis oblanceolatis saepe falcatis, ad acuminem brevem obtusum abrupte angustatis, ad basin cuneatis vel acutatis, 3-nerviis, supra primum dense floccosis mox glabratis verruculosis, subtus arcte tomentosulis, nervis secondariis obscuris; floribus longe pedunculatis in axillis foliorum solitariis; hypanthio cyathiforme; sepalis ovato-triangularibus acuminatis; petalis unguiculatis lamina rotundata; staminibus conniventibus; filamentis crassis; antheris in annulum conniventibus semicircularibus biporosis; connectivo dorso elevato et ad basin in calcar triangulare erectum producto; stylo elongato basi pubescente.

A tree 4–6 m. high; the youngest branches conspicuously flattened, densely and very closely tomentose with matted cinnamon-brown hairs, later becoming subterete and subglabrous; petioles stout, 12–17 mm. long, thinly but closely tomentulose; leaf-blades rather thick and leathery, opaque, oblanceolate, 7–10 cm. long, 3–4 cm. wide, abruptly and often falcately narrowed to an obtuse acumen 1 cm. long, cuneate or acute at base, entire, 3-nerved, floccose above when young, the brown hairs soon deciduous and the mature surface glabrous and verruculose, thickly ferruginous-tomentose beneath when young, the tomentum becoming at maturity so thin and closely matted that the surface appears glabrous; secondaries obsolete above, obscure beneath; flowers solitary; pedicels single in the axils, very stout, 4 cm. long, tomentose

like the stem; hypanthium broadly cyathiform, about 15 mm. wide, deciduously floccose; sepals triangular-ovate, acuminate, reflexed, about 1 cm. long; petals pink, broadly rotund above an unguiculate base, 35–40 mm. long; filaments strongly flattened, 14 mm. long, nearly 2 mm. wide; anthers flattened, connivent in a ring, almost semicircular, 8.5–9 mm. long, 4–4.5 mm. wide, obtuse, opening by 2 minute terminal pores, the connective strongly elevated dorsally into a flat ridge and prolonged at base into an erect, flat, triangular spur 5 mm. high; ovary wholly inferior; style stout, somewhat sigmoid, 23 mm. long, enlarged distally, thinly pubescent on the lower third; stigma punctiform.

Type, *KS 25671*, collected at edge of a sphagnum swamp at Eneñas, on the Pichis Trail, Dept. Junín, Peru, alt. 1700 m. The specimen unfortunately displays but a single flower somewhat past full anthesis, and it has not been possible to ascertain its structure fully. The species seems to be related to *B. Spruceana* Cogn., differing from that plant in its oblanceolate leaves with well developed acumen, the absence of strigose hairs, the dense tomentum, the stout solitary peduncles, and the much larger flowers.

BLAKEA REPENS (R. &. P.) Don. Dept. Junín, Pichis Trail: *KS 25631*.

BLAKEA SAWADAE Macbr. Pampayacu: *Macbride 5058* (isotype); Dept. Junín, Pichis Trail: *KS 26086*.

BLAKEA SPRUCEANA Cogn. Dept. San Martín, San Roque: *W 7383*.

MOURIRIA Aubl.

MOURIRIA CAULIFLORA DC. Dept. Loreto, Mishuyacu: *K 1374, 1410*. In the lack of authentic material of this species for comparison, these specimens are doubtfully referred here.

MOURIRIA OLIGANTHA Pilger. Dept. Loreto, lower Río Huallaga: *W 3904*.

MOURIRIA SAGOTIANA Triana. Dept. Loreto, Mishuyacu: *K 1501*.

NEW YORK BOTANICAL GARDEN

Thorn formation in Fouquieria splendens and Idria columnaris

Robert R. Humphrey

During the course of a series of investigations on *Fouquieria splendens* Engelm., and *Idria columnaris* Kellogg, two members of a little known family limited in its range to the southwestern United States and Mexico, it has been deemed advisable by the writer to give a preliminary account of thorn formation in the first of these two species.

Both plants possess a peculiarity fairly common among desert perennials—that of losing their leaves during periods of drouth and regaining them within two days to a week following periods of even moderate precipitation. This may be repeated seven or eight times during the course of a single year.

These leaves occur only when elongation of the branches is taking place, and consequently are almost never seen except during the middle to the latter part of the summer rains, before the drouth of the late summer sets in.

As the branches elongate the leaves formed at that time are composed of a small blade and what appears to be a very thick petiole. With the advent of dry weather and consequent cessation of growth, the apparent petiole is seen to split for its whole length in a horizontal plane and the upper one-quarter with the leaf blade attached falls off, leaving a stout, sharp-pointed spine.

It is currently believed among those who have observed the plant that the thorns are modified petioles, serving to protect the plant after the leaves are shed. A detailed study of *F. splendens*, however, indicates that the thorn is an outgrowth of the cortex and epidermis. The petiole is attached along its complete ventral surface to the spine, and the formation of the abscission layer preceding the dropping of the leaves is along this juncture.

The thorns of *Idria* are of the same type and are in all probability formed in the same manner.

The leaves may be divided into two types, based on their origin and manner of growth. The type most commonly observed has the general appearance of a typical mesic leaf, and occurs in clumps of two to six or occasionally more, in the axils of the rather stiff thorns with which the plant is clothed. It is these leaves which, through their loss and renewal, indicate the soil water available to the plant.

The other type is encountered less often, usually during only a limited portion of the summer and is the form of particular interest in this paper.

At the time the cork layer is forming the thorns are simple in structure, possessing a single layer of epidermal cells which are continuous with those of the petiole, while beneath the epidermis is an unbroken mass of parenchyma cells increasing in size toward the center and almost entirely without intercellular spaces. The cortical cells immediately beneath the epidermis and extending inward 1/6 to 1/10 the radius of the thorn are filled with a dense cytoplasm extending around the thorn portion of the compound structure. The petiole at this stage is much like the spine, except for the presence of the vascular system, which is much the shape of an inverted yoke extending approximately two-thirds of the way across the petiole. The leaf blade is indicated at this stage by ear-like outgrowths of the epidermis and cortex at either side of the ventral surface.

SUMMARY

1. The thorns of *Fouquieria splendens* are not formed from the leaf petiole, as commonly supposed, but are simply cortical and epidermal outgrowths.

2. Abcission of the primary leaves takes place along the whole dorsal surface of the petiole and the upper surface of the thorn.

3. The thorns of *Idria columnaris* are probably morphologically similar to those of *Fouquieria splendens*.

Desert Laboratory of the Carnegie Institution of Washington
Tucson, Arizona

INDEX TO AMERICAN BOTANICAL LITERATURE

1929–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the work America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Adriance, G. W. Factors influencing fruit setting in the pecan. Bot. Gaz. **91:** 144–166. *f. 1–6.* 15 Ap 1931.

Allen, O. N., & Baldwin, I. L. The effectiveness of *Rhizobia* as influenced by passage through the host plant. Wisconsin Agr. Exp. Sta. Res. Bull. 106: 1–56. *pl. 1–10+f. 1–7.* Ja 1931.

Ames, O., & Quisumbing, E. New or noteworthy Philippine orchids, I. Philippine Jour. Sci. **44:** 369–383. *pl. 1–16.* Ap 1931.

Amours, O. C. d'. La theorie des chromosomes. Son origine—son explication—sa valeur—son utilité. Nat. Canadien **58:** 39–42. F 1931; 58–61. Mr 1931; 84–91. Ap 1931; 97–104. My 1931.

Ashe, W. W. Notes on *Magnolia* and other woody plants. Torreya **31:** 37–41. Mr–Ap 1931.

Magnolia australis and *Quercus mississippiensis* described as new.

Auten, B. C. Root rot. Am. Peony Soc. Bull. **27:** 19–20. Mr 1931.

Austin, L. The Eddy tree breeding station. Madrono **1:** 203–212. *f. 1–5.* Jl 1929.

Baker, M. S. Field notes on certain *Brodiaea* species in Humboldt County. Madrono **1:** 199–200. Mr 1929.

Barbosa, C. Revestimentos floristicos do Brasil. (Relevos e paizagens). Bol. Agr. Est. Sao Paulo **31:** 1265–1312. *f.* 1–12. D 1930.

Barrus, M. F. Pear diseases and their control. Cornell Agr. Exp. Sta. Entom. Bull. 203: 17–30. Ja 1931.

Baxter, E. M. *Opuntia Gosseliniana,* Weber. Jour. Cactus and Succ. Soc. Am. **2:** 458. *illust.* Ap 1931.

Bay, J. C. Jean Senebier. 1742–1808. Plant Physiol. **6:** 189–193. *pl. 6.* Ja 1931.

Beadle, G. W. A gene in maize for supernumerary cell divisions following meiosis. Cornell Agr. Exp. Sta. Mem. 135: 1–12. *pl. 1–3+f. 1.* Mr 1931.

Bödeker, F. *Mamillaria surculosa* Böd. sp. n. Monats. Deutsch. Kakteen-Gesell. **3**: 78–80. *illust.* Ap 1931.

A Mexican plant.

Bödeker, F. Über *Mamillaria* (Neomamill.) *Saffordii* Rose und *Mamillaria Carrettii* Reb. cat. Monats. Deutsch. Kakteen-Gesell. **3**: 80–81. *illust.* Ap 1931.

Bowers, C. G. The development of pollen and viscin strands in *Rhododendron catawbiense.* Bull. Torrey Club **57**: 285–313. *pl. 11–15+f. 25, 26.* "My 1930" 20 My 1931.

Bressman, E. N. Rye infected with bunt of wheat. Phytopathology **21**: 437–440. *f. 1, 2.* Ap 1931.

Brierley, W. G. A study of senescence in the red raspberry cane. Minnesota Agr. Exp. Sta. Tech. Bull. 69: 1–36. *f. 1–22.* S 1930.

Briggs, F. N. Inheritance of resistance to bunt, *Tilletia Tritici*, in hybrids of White Federation and Banner Berkeley wheats. Jour. Agr. Res. **42**: 307–313. *f. 1.* 1 Mr 1931.

Broadfoot, W. C. Preliminary experiments on the control of cereal rusts by kolo dust. Phytopathology **21**: 347–372. Ap 1931.

Broadhurst, J., Moriyama, Y., & Pease, D. Conjunction of disexual forms in *Ascobacillus.* Jour. Bact. **21**: 305–310. *pl. 1.* My 1931.

Brodie, H. J. The oidia of *Coprinus lagopus* and their relation with insects. Ann. Bot. **45**: 315–344. *pl. 10+f. 1–24.* Ap 1931.

Bruner, W. E. The vegetation of Oklahoma. Ecol. Monogr. **1**: 100–188. *f. 1–31.* Ap 1931.

Burke, E. B., Morris, H. E., & Harrington, F. M. A study of apple tree growth as influenced by soil conditions in the Bitter Root Valley. Montana Agr. Exp. Sta. Bull. 241: 1–23. *f. 1–4.* F 1931.

Castle, E. S. Photopropic "indifference" and the light-sensitive system of *Phycomyces.* Bot. Gaz. **91**: 206–212: *f. 1, 2.* 15 Ap 1931.

Cejp, K. Contribution to the knowledge of the Hydnaceae and Phylacteriaceae of Iowa. Univ. Iowa Stud. Bot. **13**: 3–9. *pl. 1, 2.* 15 Mr 1931.

Charles, V. K. Some common mushrooms and how to know them. U. S. Dep. Agr. Circ. 143: 1–59. *f. 1–49.* Mr 1931.

Chester, K. S. Graft-blight: a disease of lilac related to the employment of certain understocks in propagation. Jour. Arnold Arbor. **12**: 79–146. *pl. 31–34.* Ap 1931.

Chowdbury, K. A. Anatomical studies of the wood of a hybrid larch. Jour. Forest. **29**: 797–805. *f. 1, 2.* My 1931.

Christensen, B. V. Collection of medicinal plants in Florida. Florida Dep. Agr. Bull. 45: 1–32. *f. 1–17.* O 1930.

Christensen, B. V. Some drug plants in Florida. Florida Dep. Agr. Bull. 14: 1–28. *f. 1–12.* Ja 1929.

Christensen, C. Asiatic Pteridophyta collected by Joseph F. Rock 1920–1924. Contr. U. S. Nat. Mus. **26**: 265–337. *pl. 13–29.* 1931.

Clark, F. R. Temperature as a possible factor in regeneration. Plant Physiol. **6**: 196. Ja 1931.

Clark, N. A., & Roller, E. M. The stimulation of *Lemna major* by organic matter under sterile and non-sterile conditions. Soil Sci. **31**: 299–308. *pl. 1+f. 1.* Ap 1931.

Clute, W. N. The Juneberry. Am. Bot. **37**: 49–50. *illust.* Ap 1931.

Coburn, H. R., & Dean, D. L. The effect of increased activities and change in mode of transportation upon the distribution of introduced species in the vicinity of Douglas Lake, Michigan. Bull. Torrey Club **57**: 339–346. "My 1930" 20 My 1931.

Colley, M. W. Stimulation phenomena in the growth of bacteria as determined by nephelometry. Am. Jour. Bot. **18**: 266–287. 15 Ap 1931.

Cooper, W. S. The seed-plants and ferns of the Glacier Bay National Monument, Alaska. Bull. Torrey Bot. Club **57**: 327–338. "My 1930" 20 My 1931.

Crafts, A. S. Movement of organic materials in plants. Plant Physiol. **6**: 1–38. *pl. 2–5.* Ja 1931.

Crosby, C. R., & Chupp, C. The control of diseases and insects affecting vegetable crops. Cornell Agr. Exp. Sta. Ext. Bull. 206: 1–99. *f. 1–10.* F 1931.

Currence, T. M. Inheritance studies in *Phaseolus vulgaris.* Minnesota Agr. Exp. Sta. Tech. Bull. 68: 1–28. *f. 1–9.* Au 1930.

Darlington, H. T. The 50-year period for Dr. Beal's seed viability experiment. Am. Jour. Bot. **18**: 262–265. *f. 1.* 15 Ap 1931.

Davis, W. C. Phenolase activity in relation to seed viability. Plant. Physiol. **6**: 127–138. *f. 1–3.* Ja 1931.

Degener, O. Illustrated guide to the more common or noteworthy ferns and flowering plants of Hawaiian National Park. i–xv, 1–312. *pl. 1–95+f. 1–45.* Honolulu, 1930.

Demerec, M. Behavior of two mutable genes of *Delphinium Ajacis*. Jour. Genetics **24**: 179–193. *pl. 4+f. 1–7*. Ap 1931.

Dermen, H. Polyploidy in *Petunia*. Am. Jour. Bot. **18**: 250–261. *pl. 21*. 15 Ap 1931.

Domin, K. Phylogenetic evolution of the phyllome. Am. Jour. Bot. **18**: 237–242. 15 Ap 1931.

Donat, A. Ueber die Verbreitung einiger Desmidiaceen IV. Pflanzenareale **3**: *pl. 12–17*. 1931.

Dunn, M. S. Trees. Am. Jour. Pharm. **103**: 185–207. *f. 1–7*. Ap 1931.

Duruz, W. P. Peach rust and its control. Month. Bull. Dep. Agr. California 20: 240–248. *f. 20–23*. Mr 1931.

Eaton, F. M. Early defloration as a method of increasing cotton yields, and the relation of fruitfulness to fibre and boll characters. Jour. Agr. Res. **42**: 447–461. *f. 1–3*. 15 Ap 1931.

Eaton, R. J. Peculiar aspects of the New England distribution of *Arceuthobium pusillum*. Rhodora **33**: 92–101. *Maps 1–4*. 10 Ap 1931.

Eaton, S. V. Effects of variation in day-length and clipping of plants on nodule development and growth of soy bean. Bot. Gaz. **91**: 113–143. *f. 1–5*. 15 Ap 1931.

Eckhardt, M. McL., Baldwin, I. L., & Fred, E. B. Studies of the root-nodule organism of *Lupinus*. Jour. Bact. **21**: 273–285. Ap 1931.

Erdtman, G. Pollen-statistics: a new research method in paleo-ecology. Science II. **73**: 399–401. *f. 1*. 10 Ap 1931.

Ewan, J. Five thousand feet of plants. Am. Bot. **37**: 58–64. Ap 1931.

Ezekiel, W. N. Studies on the nature of physiologic resistance to *Puccinia graminis Tritici*. Minnesota Agr. Exp. Sta. Tech. Bull. 67: 1–62. *f. 1–11*. O 1930.

Fenner, L. M. Bacterial canker of tomato and its distribution with the seed from infected fruit. Jour. Econ. Entom. **24**: 544–547. Ap 1931.

Fernald, M. L. A new blackberry from New Hampshire. Rhodora **33**: 102–104. 10 Ap 1931.

Rubus severus Brainerd n. sp.

Florell, V. H. A cytological study of wheat×rye hybrids and back crosses. Jour. Agr. Res. **42**: 341–362. *f. 1–9*. 15 Mr 1931.

Florell, V. H. A genetic study of wheat×rye hybrids and back crosses. Jour. Agr. Res. **42**: 315–339. *f. 1–7*. 15 Mr 1931.

Foster, A. S. Phylogenetic and ontogenetic interpretations of the cataphyll. Am. Jour. Bot. **18**: 243–249. 15 Ap 1931.

Frick, G. A. *Euphorbia tirucalli* vs. *E. laro*. Jour. Cactus and Succ. Soc. Am. **2**: 453–454. *illust.* Ap 1931.

Frick, G. A. Geboortebsperking in het Plantenrijk. Succulenta **13**: 61–63. Ap 1931.

Fritz, E. Some popular fallacies concerning California redwood. Madrono **1**: 221–224. Jl 1929.

Frye, Mrs. E. A. *Campanula Piperii.* New Flora and Silva **3**: 185–186. *pl. 71.* Ap 1931.

Gabrielson, I. N. Some North American dwarf *Phlox*. New Flora and Silva **3**: 157–164. *pl. 59–60.* Ap 1931.

Gaiser, L. O. Chromosome numbers in Angiosperms. III. Genetica **12**: 161–260. 1930.

Gilbert, B. E., & Pember, F. R. Further evidence concerning the toxic action of aluminium in connection with plant growth. Soil Sci. **31**: 267–273. Ap 1931.

Graber, L. F. Food reserves in relation to other factors limiting the growth of grasses. Plant Physiol. **6**: 43–71. *f. 1–4.* Ja 1931.

Gran, H. H., & Angst, E. C. Plankton diatoms of Puget Sound. Publ. Puget Sound Biol. Sta. **7**: 417–519. *f. 1–95.* 30 Mr 1931.

Graves, A. H. Important woody plants—trees, shrubs and woody climbers—of Greater New York, Brooklyn Bot. Gard. Leafl. 19: 1–7. 22 Ap 1931.

Green, J., & Johnson, A. H. Effect of petroleum oils on the respiration of bean leaves. Plant Physiol. **6**: 149–159. *f. 1–5.* Ja 1931.

Greene, E. L. Why the *Eschscholtzia*? Madrono **1**: 195–197. Mr 1929.

Greene, H. A. Historical note on the Monterey Cypress at Cypress Point. Madrono **1**: 197–198. Mr 1929.

Griscom, L. Dwarf mistletoe and other plants new to New Jersey. Rhodora **33**: 101. 10 Ap 1931.

Guterman, C. E. F. Diseases of lilies. Year Book Hort. Soc. N. Y. **1930**: 51–102. *f. 1–11.* 1930.

Haas, A. R. C., & Halma, F. F. Sap concentration and inorganic constituents of mature *Citrus* leaves. Hilgardia **5**: 409–424. *f. 1–11.* Mr 1931.

Haas, A. R. C., & Klotz, L. J. Nutrition and composition of the Deglet noor palm in relation to the decline disease. Hilgardia **5**: 511–530. *f. 1–5.* Ap 1931.

Halma, F. F., & Haas, A. R. C. Solubility changes of inorganic constituents in *Citrus* cuttings. Bot. Gaz. **91:** 213–218. *f. 1, 2.* 15 Ap 1931.

Haring, I. M. Plant growth under electric light. Bryologist **33:** 89–91. "N 1930" 16 Mr 1931.

Harper, R. M. Exotic plants in forests: supplementary note. Torreya **31:** 48–49. Mr–Ap 1931.

Harris, J. A., & Gunstad, B. Extension of Pearson's correlation method to intraclass and interclass relationships. Jour. Agr. Res. **42:** 279–291. 1 Mr 1931.

Hatfield, I. Control of moisture content of air and wood in fresh-air chambers. Jour. Agr. Res. **42:** 301–305. *illust.* 1 Mr 1931.

Hoehne, F. C. As plantas ornamentaes da flora Brasilica e seu papel como factores da Salubridade publica, da esthética urbana e artes decoratoras nacionaes. Bol. Agr. Est. Saŏ Paulo **31:** 1211–1241. *illust.* D 1930.

Holch, A. E. Development of roots and shoots of certain deciduous tree seedlings in different forest sites. Ecology **12:** 259–298. *f. 1–24.* Ap 1931.

Holm, T. The seedling of *Hamamelis virginiana* L. Rhodora **33:** 81–92. *pl. 206–207.* 10 Ap 1931.

Howell, J. T. The flora of the Santa Ana Canon region. Madrono **1:** 243–253. D 1929.

Howell, J. T. Plantae occidentales I. Madrono **2:** 11–15. Au 1930; II. 18–23. Mr 1931.

Hursh, C. R., & Hassis, F. W. Effects of 1925 summer drought on southern Appalachian hardwoods. Ecology **12:** 380–386. *f. 1–3.* Ap 1931.

Husted, L. Cell wall of *Vaucheria geminata.* Bot. Gaz. **91:** 219. 15 Ap 1931.

Ingalls, R. A., & Shive, J. W. Relation of H-ion concentration of tissue fluids to the distribution of iron in plants. Plant Physiol. **6:** 103–125. *f. 1–10.* Ja 1931.

J[ack], J. G. Effect of cold on flower buds of trees and shrubs. Arnold Arbor. Bull. Pop. Inf. **5:** 1–4. *illust.* 23 Ap 1931.

Jenkins, A. E. Development of brown canker of roses. Jour. Agr. Res. **42:** 293–299. *pl. 1+f. 1–4.* 1 Mr 1931.

Jepson, W. L., Johann Friederich Eschscholtz. Madrono **1:** 253. *Portrait.* D 1929.

Jepson, W. L. Physiological bilabiation and physiological irregularity in the flowers of California Angiosperms. I. Madrono **1:** 198–199. Mr 1929.

Jepson, W. L. A revision of Californian Umbelliferae. V. Madrono **1:** 281–285. D 1929.

Jepson, W. L. Sertulum Californiense. I. Madrono **1:** 254–260. D 1929.

Jepson, W. L. Variation in the pappus of *Layia pentachaeta* Gray. Madrono **1:** 200–201. Mr 1929.

Johansen, D. A. The function of the cactus spine. Desert **2:** 153, 156. Ap 1931.

Jones, D. F. Dioecious maize. Science II. **73:** 432. 17 Ap 1931.

Jones, E. N. The morphology and biology of *Ceratophyllum demersum*. Univ. Iowa Stud. Bot. **13:** 11–46. *pl. 1–4.* 15 Mr 1931.

Jones, G. N. New or noteworthy plants of the Pacific northwest. I. State Coll. Washington Res. Stud. **2:** 125–129. *illust.* D 1930.

Jones, L. K. The mosaic disease of beets. St. Coll. Washington Agr. Exp. Sta. Bull. 250: 1–16. *f. 1–4.* Mr 1931.

Keng, Y. L. New grasses from China. Jour. Washington Acad. Sci. **21:** 155–160. *f. 1–3.* 19 Ap 1931.

Kienholz, R. Effect of environmental factors on the wood structure of lodgepole pine, *Pinus contorta* Loudon. Ecology **12:** 354–379. *f. 1–12.* Ap 1931.

Klages, K. H. Geographical distribution of variability in the yield of cereal crops in South Dakota. Ecology **11:** 334–345. *f. 1–4.* Ap 1931.

Koch, K. The potato rugose mosaic complex. Science II. **73:** 615. 5 Je 1931.

Knuth, R. Dioscoreaceae novae. Repert. Spec. Nov. **29:** 92–96. 10 Ap 1931.

Includes ten new species from South America.

Leach, J. G. Further studies on the seed-corn maggot and bacteria with special reference to potato blackleg. Phytopathology **21:** 387–406. *f. 1–14.* Ap 1931.

Ledoux, P. Etudes sur la Flore du Bas-Amazone (Etat de Pará, Brésil). Imp. Med. and Sci. Bruxelles. 1–9. *pl. 1–5.* 1930.

Leon, (Frère). Apports de la botanique à la geographie specialement dans les Grandes Antilles. Rev. Soc. Geogr. Cuba 1–11. 1931.

Leonard, E. C. The genus *Mendoncia* in Peru. Jour. Washington Acad. Sci. **21:** 144–152. 4 Ap 1931.

Six species are described as new.

L[inder], D. H. Some diseases of elm trees. Missouri Bot. Gard. Bull. **19:** 61–69. *pl. 16, 17.* Ap 1931.

Lloyd, J. U., & Lloyd, C. G. Drugs and medicines of North

America. Bull. Lloyd Lib. **29**: 1–184. *pl. 1–11*+*f. 1–43*. 1930; **30**: 187–299. *pl. 12–25*+*f. 44–105*. 1931.

Ma, R. M. Starch deposition in the sporogenous cells of certain mosses. Bull. Torrey Club **57**: 525–532. *pl. 31*. "N 1930" 25 Au 1931.

Ma, R. M. The chloroplasts of *Selaginella*. Bull. Torrey Club **57**: 277–284. *pl. 10*. "My 1930" 20 My 1931.

Mc Clelland, C. K. Effects of various plant foods on growth activities and development of oats. Jour. Am. Soc. Agron. **23**: 304–311. Ap 1931.

Mc Clelland, C. K. The genetics, breeding and improvement of corn. A bibliography covering more than 40 years work (1889–1929) in the breeding, improvement, and study of inheritance in corn. 1–48. Fayettville, Ark., N 1930.

Mc Clelland, C. K. The genetics, breeding and improvement of cotton. A bibliography covering more than 40 years (1889–1929) in the breeding, improvement and study of inheritance in cotton. 1–24. Fayettville, Ark., N 1930.

Mc Clintock, J. A. Cross-inoculation experiments with *Erigeron* yellows and peach rosette. Phytopathology **21**: 373–386. *f. 1–3*. Ap 1931.

Mc Hargue, J. S., & Calfee, R. K. Effect of manganese, copper, and zinc on growth and metabolism of *Aspergillus flavus* and *Rhizopus nigricans*. Bot. Gaz. **91**: 183–193. *f. 1–7*. 15 Ap 1931.

Mackie, W. W. Diseases of grain and their control. California Agr. Exp. Sta. Bull. 511: 1–87. *f. 1–46*. Ap 1931.

Malme, G. O. A. N. Die Leguminosen der zweiten Regnellschen Reise. Ark. Bot. **23A**[13]: 1–99. 24 Mr 1931.

Marchionatto, J. B. Sobre algunos hongos parasitos de las Gramineas toxicos para el Ganado. Bol. Min. Agr. Nac. Argentina **29**: 457–462. *f. A*. D 1930.

Marshall, R. An experimental study of the water relations of seedling conifers with special reference to wilting. Ecol. Monogr. **1**: 37–98. *f. 1–15*. Ja 1931.

Marshall, R. E. Black raspberry studies. Michigan Agr. Exp. Sta. Tech. Bull. **111**: 1–32. *f. 1–6*. F 1931.

Martin, W. H. Diseases of 1928 and 1929 arranged by hosts. New Jersey Agr. Exp. Sta. Ann. Rep. **51**: 235–254. 1930.

Mason, H. L. The Santa Cruz Island pine. Madrono **2**: 8–10. Au 1930.

Mason, H. L. Two new California plants. Madrono **2**: 23. Mr 1931.

Linanthus Peirsoni and *Utricularia gibba*, spp. nov.

Mathews, W. C. Measurements of *Cupressus pygmaea* Sarg. on the Mendocina "Pine Barrens" of "White Plains." Madrono **1**: 216–218. Jl 1929.

Melchior, H. Über das Vorkommen der Gattung *Gentiana*, sektion Endotricha, in den peruanischen Anden. Ber. Deutsch. Bot. Gesell. **49**: 115–122. *pl. 6–9.* 27 Mr 1931.

Merrill, E. D. On the desirability of an actual examination of extant types of Chinese species. Sinensia Spec. Bull. **1**: 1–10. D 1930.

Michaels, W. H. Respiration of the shoot as affected by temperature changes of the root. Bot. Gaz. **91**: 167–182. *f. 1–5.* 15 Ap 1931.

Miller, P. A., & Barrett, J. T. Cantaloupe powdery mildew in the Imperial Valley. California Agr. Exp. Sta. Bull. 507: 1–36. *f. 1–13.* F 1931.

Mills, W. D. Other pear diseases. Cornell Agr. Exp. Sta. Ext. Bull. 203: 30–33. Ja 1931.

Moldenke, H. N. Interesting plant collections from Somerset County, New Jersey. Torreya **31**: 29–36. Mr–Ap 1931.

Morton, F. Guatemala. Vegetationsbilder **22**: *pl. 1–6.* 1931.

Mowry, H., & Toy, L. R. Miscellaneous tropical and sub-tropical Florida fruits. Florida Agr. Exp. Sta. Bull. 223: 1–88. *f. 1–74.* Ja 1931.

Navashin, M. Chromatin mass and cell volume in related species. Univ. California Publ. Agr. Sci. **6**: 207–230. *f. 1–3.* 14 Ap 1931.

Navashin, M. Spontaneous chromosome alterations in *Crepis tectorum* L. Univ. California Publ. Agr. Sci. **6**: 201–206. *f. 1.* 14 Ap 1931.

Nicolas, G. Sur la présence d'une Malvacée mexicaine dans le Département du Doubs. Bull. Soc. Bot. France **77**: 667–668. F 1931.

Norton, J. B. S. Maryland grasses. Maryland Agr. Exp. Sta. Bull. 323: 251–326. *pl. 1–6+f. 1.* S 1930.

Oliveira, B. d'. "*Cephalothecium roseum*" Corda. Subsidios para o estudo da podridão rosea do Coracão das macãs. Rev. Agron. Lisboa **18**: [1–83]. 1930.

Park, O. The measurement of daylight in the Chicago area and its ecological significance. Ecol. Monogr. **1**: 189–230. *f. 1–13.* Ap 1931.

Parry, C. C. From San Diego to the Bay of All Saints, lower California, and back—notes of a botanist visiting Mexican soil. Madrono **1**: 218–221. Jl 1929.

Patterson, P. M. The mosses of Mt Desert Island, Maine. Bryologist **33**: 83–89. "N 1930" 16 Mr 1931.

Pennell, F. W. On some critical species of the Serpentine Barrens. Bartonia **12**: 1–53. *pl. 1–3+f. 1–4.* 28 F 1931.

Pitman, E. M. *Pohlia proligera* in the city. Bryologist **33**: 91. "N 1930" 16 Mr 1931.

Pittier, H. Botanical notes on, and descriptions of, new and old species of Venezuelan plants. IV. *Berberis* in Venzuela, new species of *Oxalis*, *Exogonium* and others. Jour. Washington Acad. Sci. **21**: 134–143. 4 Ap 1931.

Pomerleau, R. Notes sur quelques maladies des arbres forestiers du Québec. Nat. Canadien **58**: 73–82. Ap 1931.

Poole, C. F. The interspecific hybrid, *Crepis rubra*×*C. foetida*, and some of its derivatives. I. Univ. California Publ. Agr. Sci. **6**: 169–200. *pl. 9–11+f. 1–7.* 17 Mr 1931.

Purdy, C. The influence of fire on western American flora. Nat. Hort. Mag. **10**: 130–133. Ap 1931.

Quisumbing, E. Water glass as a medium for permanently mounting dissections of herbarium material. Torreya **31**: 45–47. Mr–Ap 1931.

Ramirez Laguna, A. Contribucion para el conocimento de los Agaves de Mexico II. *Agave salmiana* Otto. An. Inst. Biol. Univ. Mexico **2**: 91–95. *f. 1, 2.* 1931.

Rea, H. E. Grafting experiments with cotton. Plant Physiol. **6**: 193–196. *f. 1.* Ja 1931.

Rickett, H. W. Flora of Columbia, Missouri. Univ. Missouri Stud. **6**: 1–84. 1 Ja 1931.

Ridley, H. N. The dispersal of plants throughout the world. i–xx, 1–744. *pl. 1–22.* London, W. Cloves & Sons, 1930.

Rieman, G. H. Genetic factors from pigmentation in the onion and their relation to disease resistance. Jour. Agr. Res. **42**: 251–278. *pl. 1–3.* 1 Mr 1931.

Rountree, L. Some California Castilleias. Nat. Hort. Mag. **10**: 112–113. *illust.* Ap 1931.

Rudolph, A. Dr. John Torrey's Herbarium and library. N. Y. Jour. Pharm. **8**: 92–94. *illust.* Ap 1931.

Runnels, H. A., & Schaffner, J. H. Manual of Ohio weeds. Ohio Agr. Exp. Sta. Bull. 475: 1–166. *f. 1–34.* Ap 1931.

Sayre, J. D., & Morris, V. H. Use of expressed sap in physiologic studies of corn. Plant Physiol. **6**: 139–148. *f. 1–4.* Ja 1931.

Sharp, A. J. A lichen as a substratum for mosses. Bryologist **33**: 83. "N 1930" 16 Mr 1931.

Sherff, E. E. New or otherwise noteworthy Compositae VI. Bot. Gaz. **91**: 308–319. 15 My 1931.

Skottsberg, C. C. V. B. Marquand's "Additions to the flora of the Falkland Islands." Meddel. Goteborgs Bot. Trad. **4:** 303–306. "1928" 16 F 1929.

Skutch, A. F. Some reactions of the banana to pressure, gravity and darkness. Plant Physiol. **6:** 73–102. *f. 1–14.* Ja 1931.

Small, J. K. Botanical crossroads, historic and prehistoric. Jour. N. Y. Bot. Gard. **32:** 92–94. Ap 1931.

Smith, E. C. Ecological observations on Colorado Myxomycetes. Torreya **31:** 42–44. Mr–Ap 1931.

Smith, L. B. Some common Polypores of New England. Boston Soc. Nat. Hist. Bull. **59:** 13–20. *f. 1–3.* Ap 1931.

Smith, R. E. The life history of *Sclerotinia sclerotiorum* with reference to the green rot of apricots. Phytopathology **21:** 407–423. *f. 1–6.* Ap 1931.

Soth, M. E. (Mrs.). Early spring in the Pacific northwest. Am. Bot. **37:** 51–53. Ap 1931.

Sparrow, F. K. Jr. Two new species of *Pythium* parasitic in green algae. Ann. Bot. **45:** 257–277. *pl. 9+f. 1, 2.* Ap 1931.

Stancliff, J. O. Early spring in Florida. Am. Bot. **37:** 64–66. Ap 1931.

Stewart, G., & Woodward, R. W. Inheritance in a wheat cross between hybrid 128×White Odessa and Kanred. Jour. Agr. Res. **42:** 507–520. *f. 1–3.* 15 Ap 1931.

Stout, A. B. Emil Godfred Arzberger, 1877–1930. Phytopathology **21:** 345–346. *portrait.* Ap 1931.

Stout, A. B. Plant hybrids. Jour. N. Y. Bot. Gard. **32:** 73–92. *f. 1–3.* Ap 1931.

Stout, A. B. The inter-relations between vegetative propagation and seed reproduction. Rep. and Proc. 9th Internat. Hort. Congr. 1930: 187–196. 1930.

Taubenhaus, J. J., Ezekiel, W. N., & Rea, H. E. Strangulation of cotton roots. Plant Physiol. **6:** 161–166. *f. 1, 2.* Ja 1931.

Taylor, N. William Cashman Ferguson, 19 November 1861–3 June 1930. Torreya **31:** 50–51. Mr-Ap 1931.

Thomas, H. E., & Thomas, H. E. Plants affected by fire blight. Phytopathology **21:** 425–435. Ap 1931.

Thomas, R. P. The relation of nitrate nitrogen and nitrification to the growth of tobacco following timothy. Wisconsin Agr. Exp. Sta. Res. Bull. **105:** 1–28. *f. 1–7.* D 1930.

Tottingham, W. E., Shands, R. G., & Delwiche, E. D. Tests of Chibnall's method of extraction for investigating winter hardiness of plants. Plant Physiol. **6:** 167–176. *f. 1–10.* Ja 1931.

Trelease, S. F. The work of Dr. Burton E. Livingston as permanent Secretary of the American Association. Sci. Monthly **32:** 281–283. *Portrait.* Mr 1931.

Truax, A. L. Some unusual wild flowers of the northern High Plains. Nat. Hort. Mag. **10:** 104–106. Ap 1931.

Uphof, J. C. T. Die Geographische Verbreitung der Familie der Batidaceae. Pflanzenareale **3:** *pl. 11.* 1931.

Volkes, M. M. Nuclear division and development of sterigmata in *Coprinus atramentarius.* Bot. Gaz. **91:** 194–205. *f. 1–48.* 15 Ap 1931.

Walther, E. Notes on *Sedum.* Jour. Cactus and Succ. Soc. Am. **2:** 455–457. *f. 1–5.* Ap 1931.

Weeks, I. T. The life forms and habitat of *Eriogonum deserticola* Wats. Madrono **1:** 260–261. D 1929.

Weston, W. H. Jr. Pharmacien Frechou and the germination of *Sclerospora oospores.* Phytopathology **21:** 441–443. Ap 1931.

White, R. P. Diseases of ornamental plants. New Jersey Agr. Exp. Sta. Circ. 226: 1–98. *f. 1–52.* F 1931.

Wieland, G. R. A flowering Cycadeoid from the Isle of Wight. Science II. **73:** 370–372. 3 Ap 1931.

Williams, R. S. Colombian mosses, apparently undescribed. Bryologist **33:** 73–77. *pl. 10–14.* "N 1930" 16 Mr 1931.

Wimmer, F. E. Lobelioideae aus den Museum des Königl. Botanischen Gartens zu Kew in England und einige aus anderen Sammlungen. Repert. Spec. Nov. **29:** 49–92. 10 Ap 1931.

Describes many new species from South and Central America.

Zimmerman, P. W. Observations on root growth from cuttings. Jour. N. Y. Bot. Gard. **32:** 96–97. Ap 1931.

Zahlbruckner, A. Neue Flechten—X. Ann. Myc. **29:** 75–86. 1931.

Describes several new species from South America.

Botanical results of the Tyler-Duida Expedition

H. A. GLEASON

(WITH MAP AND PLATES 17–44)

I. INTRODUCTION

The precipices of Mount Duida rise to a height of more than seven thousand feet above the lowlands of the Orinoco valley in southern Venezuela. Although within a few miles of the village of Esmeralda, which is accessible by water either by the Orinoco river through Venezuela or by the Casiquiare Canal from the Rio Negro and the Amazon, the summit remained unknown until its ascent by the members of the Tyler-Duida Expedition of the American Museum of Natural History in 1928 and 1929.

Humboldt and Bonpland visited Esmeralda and viewed the mountain in 1801; Schomburgk was there in 1839, after a memorable trip from British Guiana overland, during which he crossed the Pacaraima mountain range four times; Spruce collected there a few years later. In more recent times other scientists and explorers have seen the mountain or reached its base, but never succeeded in making the ascent.

Mount Duida stands at the western end of the mountain-complex which may be termed the Pacaraima system and which extends eastward into British Guiana, where Mount Roraima marks its eastern end. Although a thousand feet higher and discovered several years later, Roraima was earlier ascended. Its small summit was found to be the site of an extraordinary endemism, which is nevertheless nearly equaled by the flora of its slopes. In fact, the whole sandstone region adjacent to Roraima is characterized by a flora so distinct from the surrounding savannas and Amazonian forests as to merit consideration as a distinct phytogeographic unit.

The few botanists who have interested themselves in this remote region have generally considered that the flora of Duida would prove to be closely similar to that of Roraima. No one expected to find it the center of an endemism fully as remarkable as that of Roraima, if not surpassing it. Although the botanical collections of Mr. Tate, scientific leader of the Tyler-Duida Expedition, are comparatively small and represent probably less than a quarter of the flora, the number of undescribed species approaches two hundred, and among these are several of unusual taxonomic, morphological, or phytogeographical interest. Botanical science is indebted to Mr. Tate for his work, which was carried on under difficulties and in addition to his regular duties of zoölogical collecting.

[THE BULLETIN FOR APRIL (58: 203–276) WAS ISSUED 3 NOVEMBER 1931.]

The botanical collections of the expedition were presented by the American Museum of Natural History to The New York Botanical Garden and have been incorporated into its herbarium. Their study was assigned to the author of this report and has been carried on partly in New York and partly in Europe, where the rich collections at Berlin, Geneva, and Kew furnished valuable material for comparison. Specialists in various groups and two members of the expedition have assisted and their contributions give to the report a degree of completeness and authority unattainable under single authorship.

The Torrey Botanical Club likewise acknowledges with gratitude the support of numerous members and friends who have contributed to the special publishing fund.

In the taxonomic part of the report below, families are arranged according to the well-known sequence of Engler and Prantl. Arrangement of genera and species is sometimes taxonomic, sometimes alphabetical, as adopted by the various collaborators. Full citations of locality are given for each species, as far as provided by the field notes of the collector. Types of all species here described are in the herbarium of The New York Botanical Garden. Duplicates were supplied for contributing specialists wherever possible, and remaining duplicates, unfortunately few in number, are in the United States National Herbarium.

Under each family, the plants of Amazonian affinity are presented first, under the caption *Lowland species.* These include all the collections made by Tate on his journey to and from Duida and as far as the lower slopes of the mountain itself. The remainder of the collections are placed under the caption *Species of Mount Duida* and include all the plants collected on the summit or upper slopes of the mountain. This division has been made not merely for convenience but primarily because it represents a distinct phytogeographic segregation. The upper altitudinal limit of the Amazonian flora is not precisely known, and undoubtedly varies more or less, but in general probably does not exceed 2500 feet. Since no collections were made by Tate over an altitudinal belt some 2000 feet in height, extending both above and below this probable limit, the Amazonian flora is by this division separated from the distinctive flora of the Pacaraima range, and scarcely a species is known from both sides of the dividing zone. As may be expected, the lowland species of the Amazonian flora include comparatively few novelties, since it has been repeatedly and extensively collected for more than a century, although, as in every collection from Amazonian South America, some undescribed species occur.

Photographs illustrating the mountain or plants and vegetation in the field were taken by Mr. Tate and are used by permission of the American

Museum of Natural History. Maps have been constructed by Mr. Chas. B. Hitchcock from his personal field surveys.

II. NARRATIVE OF THE EXPEDITION[1]

The Tyler-Duida Expedition, organized by the American Museum of Natural History, New York, which has already been briefly reported on,[2] was sent into the field with the main objective of ascending the hitherto unclimbed Mount Duida in order to study its geography and biology and gather reports and collections of specimens. The party[3] left New York July 20, 1928; reached Esmeralda, ten miles from Duida, October 1; ascended to the summit of Duida first October 24; left Esmeralda March 18, 1929, and again landed in New York May 20.[4] The route taken was via Pará up the Amazon to Manáos; from that city up the Rio Negro to the mouth of the Casiquiare Canal and through the 212 miles of the canal to the point where its waters leave the upper Orinoco; finally up the canal for some twenty miles to Esmeralda, a tiny settlement on the north bank. Arrangements were made for our launch to return for us as nearly as possible in the middle of March, 1929.

In the late afternoon of the last day of our journey, as the boat thrust its way up the rippleless Orinoco, here about one fourth of a mile in width, the flood forest which had thus far lined its banks abruptly gave place to the savana of Esmeralda, and we noted a few hundred yards from the river a low adobe house thatched with banana and palm leaves standing in an enclosure surrounded by a wooden paling. Beyond, the grassland, upon which some two score head of cattle grazed, extended back to a row of low rocky hills, the Esmeralda Ridge. A short way up the river the bank forest reappeared. Our attention, however, was almost at once claimed and held by the sight of the stark precipices and enormous mass of Mount Duida, which rose vertically to a height of a mile and a quarter and, even though ten miles away, seemed to dominate the entire northern horizon. As we unloaded the baggage our eyes returned again and again to the object which we had traveled so far to investigate and we frequently stopped work to point out to one another some feature of its topography (Pl. 17).

[1] By G. H. H. Tate.

[2] Tate, G. H. H. and C. B. Hitchcock, The Cerro Duida region of Venezuela. Geogr. Rev. **20**: 31–52. 1930.

[3] The personnel consisted of Mr. Sidney F. Tyler, Jr., Mr. R. S. Deck, ornithologist, Mr. C. B. Hitchcock, geologist and cartographer, and the writer. The expedition was joined in Brazil by A. M. Olalla and brother with their four assistants, professional bird-collectors.

[4] As explained subsequently, Messrs. Tyler and Deck returned ahead of the expedition on account of ill health.

Two needs had to be taken care of immediately: an adequate number of Indians to work for us must be arranged for, and we had to determine just where along that formidable array of precipices and headlands an attempt to reach the summit should be launched with most probability of success. The matter of the Indians was settled fairly easily and in a few weeks we had about twenty-five men at our disposal. After careful study of the mountain, which appeared to be roughly rectangular with one of its angles

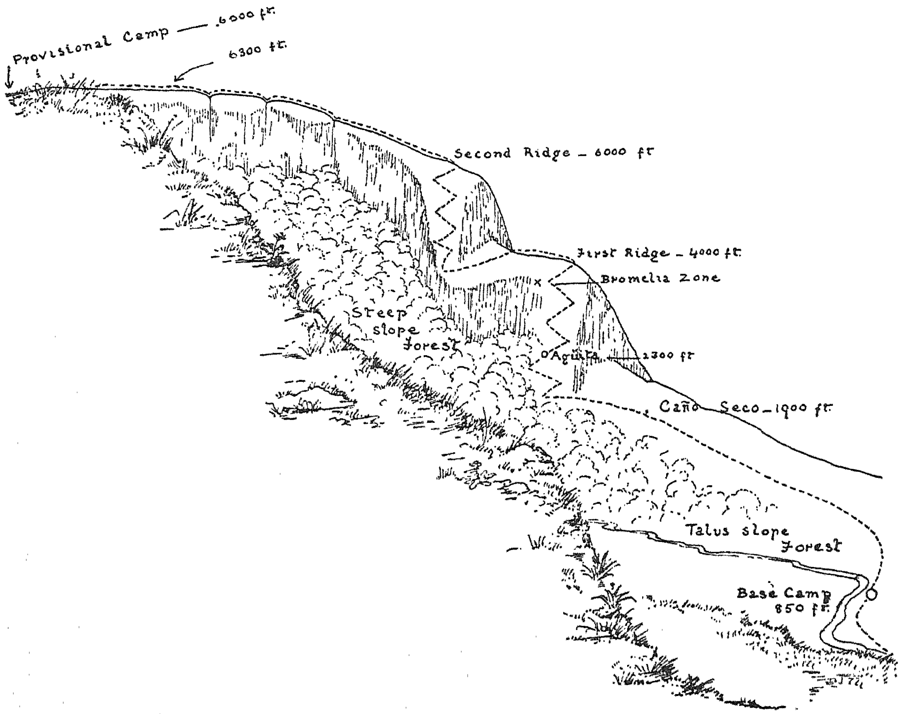


Fig. 1. Diagrammatic outline of a headland of Mount Duida: the adjacent valley occupied by forest, the headland bounded by cliffs and interrupted by two precipices. The dotted line indicates the route followed in the ascent.

pointing directly southward at us, we reached the conclusion that the southwest scarp, on account of its very precipitous and almost unbroken form, presented too great an obstacle. The side facing southeast, on the other hand, was cut up into a number of prodigious headlands separated by short ravines of immense depth. The length of the southwest face appeared about fifteen miles, that of the broken southeast face about ten miles.

Each headland appeared to consist of a higher and a lower portion, and each portion of a sharp crest terminating in a precipice with a roughly

triangular face. It seemed possible that we might ascend one of the valleys until we had passed the terminal precipice of a promontory, turn at right angles, and climb its flank up to the knife-edge crest, along which we would advance to the next precipice. Skirting its base, as in the first case, we hoped to climb its steeply sloping sides to its crest and then walk inward to the main mass of the mountain. Although even more difficult in practice than we had anticipated, the actual ascent followed more or less this plan (Fig. 1).

Having selected the most promising of the headlands and valleys, Hitchcock and I, with four Indians, food for several days, hammocks, and machetes, set out in search of the best approach. Our way took us across the Esmeralda Savana, through dense forest filled with magnificent palms, to another large and very beautiful savana (Grand Savana) situated at the foot of the southern angle of Duida. We crossed this and again plunged into forest, coming out occasionally into natural clearings filled with long grass, thickets of "caña brava," or tree savanas, concerning which more will be said later. We tried to hold our course parallel with the southeast face of the mountain, but much delay was occasioned when we crossed or had to go round large burnt areas, now covered with an almost impassable litter of great tree-trunks overgrown with lush masses of *Heliconia*, pokeweed, *Costus*, and other plants. As a rule, it was impossible to see the mountain at all, on account of the thick forest, and the occasional glimpses we had were insufficient for us to determine which part we were viewing. Eventually we came upon a good-sized stream (Base River), flowing from the foot of the cliffs at about the middle of the southeast side, and this we followed up. At length we were rewarded with a fairly uninterrupted view of the tip of one of the promontories which seemed to rise close to us, while our stream seemed to come from the ravine beside it. We reached the conclusion that this was the headland which we had selected for our attempt. We were now at the foot of the forested talus slope and made a camp (Base Camp). The next morning we started upward along the course of the stream in an attempt to pass the foot of the precipice in which the mountain spur ended. In this we were not only successful, but reached a height of 2100 feet on its flank. The weather turned bad, however, our food became exhausted, and the men tired and discouraged, so we returned to Esmeralda to refit.

There we found a number of Indians ready for work, whom we dispatched at once with orders to widen, straighten, and improve the trail, build camps at certain points, and try to cut upwards through the forest of the ridge and gain the lower crest of the promontory.

Some time later I set out again, this time with Tyler. We found that a

good straight trail had been cut through to Base Camp, that the huts were almost completed, and that the men had almost reached the lower crest of the ridge. Taking three men, we pushed up to the lower crest, where vegetation was scrubby and dwarfed, and along to the foot of the second precipice, which almost stopped us. However, we succeeded in skirting this also and put forth all our efforts for the final climb, perhaps the hardest of all, up the flank of the ridge to the higher crest. When finally we reached our objective, we found ourselves enveloped by mist. After a short rest we commenced, still ascending, to move along the crest to the body of the mountain. Difficulties continually appeared: spots where the ridge narrowed to almost nothing and the ground on either side crumbled; great hummocks of rock twenty to fifty feet high, their bases enveloped by wiry bushes, their sides and summits clothed with tough, cushiony herbage, over which we had to find our way. At length, the fog clearing for a few minutes, we found ourselves at the base of the headland adjoining the plateau and gazed over a gloomy panorama—a vast misty tableland rolling in giant waves, the whole inclining gently away from the scarp up which we had ascended. Tired out, we sat in a tangle of wiry brush which grew waist-high around us, looking right and left across great gulfs at neighboring headlands whose height cut off all further view.

Upon returning to Base Camp we instructed the Indians to improve the trail, make it their first duty to find drinking water on the plateau, and form a temporary camp on the summit (Provisional Camp).

About this time Tyler and Hitchcock and a few weeks later Deck left the expedition on account of ill health. Hitchcock returned in December, but Tyler went on down the Orinoco and eventually to New York; Deck came back so weak and ill with malaria that it seemed advisable to send him home at once.

Directly Provisional Camp on the summit was finished, I moved up there so as to be able to direct the construction of the long trails needed for getting about on the plateau. The path to the plateau was now vastly improved. In its construction more than 150 ladders and inclined bridges had been built by the Indians. The weather for the first week or so (end of November) remained generally cold and wet, but brief periods when it cleared allowed me to form a good conception of the topography of most of the mountain-top, to select localities which promised to be of major interest, and to have paths cut by which they might be reached and campsites in readiness for occupation at each one.

Road building was exceedingly hard work, partly on account of the uneven terrain, but especially because of the frightfully tangled vegetation. The men had to cut through almost continuous thickets while near

the ridge-tops, and in the valleys tunnel through a dense murky forest twenty feet in height and composed for the most part of semi-recumbent tree-trunks swathed in moss. Besides working in the rain, they were cold at night and short of rations, every scrap of which had to be carried up the ladder trail to them.

An important feature was the preparation of a central camp far enough from the edges of the cliffs to escape excessive mist and rain. The place selected was some three miles from the southeast escarpment where a maximum of sunshine was obtained daily. This station served as the main depot for reserve stores and for drying and storing specimens.

In a limited way, an understanding of the factors producing the strange fauna and flora present on Duida was not difficult. Here was an elevated mass of quartzite whose strata prior to its uplift had been profoundly folded, their strike being approximately northwest-southeast, or parallel to the southwest scarp. The headlands represented the crests of these folds; the valleys, the troughs. A gradual accumulation of vegetable matter almost unmixed with inorganic material covered most of this great area of 250 square miles of corrugated surface. Added to this was a climate intensely rainy for nine months out of the twelve and, due to elevation, a temperature between fifty and sixty degrees Fahrenheit. The result of the interplay of these factors upon any organism which was able to survive them after penetrating into the area was profound, as shown by the present biota.

On December 13 I received word that Hitchcock had returned. He asked me to go down to Esmeralda and help him measure a base line for his survey of the mountain. The weather, which had been fair for some time, broke badly at the period of "los nortes," so that I was glad to be down in the less tempestuous lowlands for a while. I returned to the summit December 21 and Hitchcock arrived ten days later. On December 30 I moved the Olalla contingent, who had hitherto been employed in the lowlands and on the slopes, into a special camp (Valley Head) on the plateau.

We planned to devote the next two months to a complete exploration of the summit. The first trail finished wound southwest along the top of the cliffs —a perfect switchback of a trail, now rising 500 feet to the crest of a fold, now falling a thousand feet to the next trough—to reach finally High Point Camp at 7600 feet. This station, representing the highest reached by us on Duida, was perched upon the southernmost tip of the plateau and overlooked not only the entire interior plateau and mountains to the north, but also the Orinoco lowlands east, south, and west for a distance of fifty miles. Along this trail several subsidiary stations were lo-

cated. It was while we occupied this camp that Deck returned and I had to go down to arrange for his transportation back to Manáos.

The work at High Point completed, we withdrew to Central Camp, stored away our collections, replenished our stores, and moved out to the station at the center of the plateau named Savana Hills. As our stay at this, the last of the camps on the summit, drew to a close, we received repeated warnings that the rainy season was iminent. Frequent afternoon storms came upon us and several heavy rains. The bridge across a deep, rock-bordered stream (Caño Negro) was twice carried away.

Reluctantly we commenced our withdrawal. Equipment and collections were moved back to Central Camp, and as quickly as possible that station also was dismantled and moved down the mountain. Short stays were made at Agüita, part way down the cliffs, and again in some of the lowland camps, but the object of the journey had been accomplished and we had little to do but move out to Esmeralda and await the launch.

III. CERRO DUIDA AND THE GUAYANA HIGHLANDS[1]

In discussing physiographic and geological relationships of the Duida region, it seems better at the present time to suggest possibilities of relationship between the mountain mass of Duida and the surrounding country of the Guayana Highlands, rather than to restrict words to local details of the mountain itself.

Mount Duida is composed of a strongly folded series of reddish and white conglomeratic sandstones and purple shales.[2] The physiographic interpretation of the mountain front suggests strongly a series of extensive faults, an extensive block mountain bounded by steep walls, but the impressiveness of the abrupt cliffs is perhaps of less interest than its summit. This surface has been referred to as a plateau, an easy method of depicting the broad extent of the summit, but from a strict definition this application of the term is quite incorrect. The summit is not a plateau, but an old mature surface partially broken by tectonic movements accompanying the up-faulting, partly dissected by processes of weathering and stream erosion.

Four hundred miles to the east lies Mount Roraima, also composed of red and white conglomeratic sandstone and red shales. These sediments were named by Dalton[3] the Roraima series. The latter, far from being com-

[1] By C. B. Hitchcock.

[2] Tate, G. H. H. and C. B. Hitchcock. The Cerro Duida region of Venezuela. Geogr. Rev. 20: 31–52. 1930.

[3] Dalton, L. V. Venezuela. London, 1912.

plexly folded, are flat bedded and appear to be the erosional remnants of a formerly widespread series.

What could be its former possible extent? A study of the scanty literature left by travellers in the country intermediate to these mountains shows that sandstone mountains occur in patches throughout the region. In the head-waters of the Rio Caroni, Holdridge[1] reports mountains of similar appearance. Toward the upper reaches of the Rio Caura, André[2] says of Cerro Arawa: "the mountain loomed ahead of us in forbidding grandeur. Just before sunset, the heavy bank of clouds which had been hanging over its summit cleared up, revealing the height of its precipitous sides, and the fantastic shapes into which the plateau had been cut." From other portions of the text it is evident that he found this mountain to be composed of sandstone. Here, as in the headwaters of the Caroni and at Roraima, are the same general types of mountains, isolated to a certain degree, but forming connecting links between the eastern extension of sandstone and the Parima system. At the headwaters of the Uraricuera and Parima, Rice[3] described folded sandstones. Schomburgk[4] observed in 1839 that the sandstone mountains, scattered along his route from Cerro Roraima to the west, became considerably more indurated as he approached the eastern flank of Sierra Parima. At the foot of Cerro Sarisharinima, of about 4000 feet elevation, he observed[5] that the rubble at its foot "ist der Sandstein auch viel crystallinischer."

It is interesting to note that as he crossed the main ridge of the Parimas he observed coarse-grained granite in which large bands of hornblende were predominant. It seems unlikely that he would mistake its general type if there were a predominantly coarse, crystalline rock of this nature. The physiographic aspect of the Parima range, when viewed from the summit of Duida, tends to substantiate this observation. Rounded, apparently wooded summits lead one to suspect an igneous or metamorphic rock as the cause of such a topographical feature.

To the west of the Parima range, we again encounter metamorphosed sandstones and shales at Duida. A hundred miles to the west Cerro Yapacana, which stands near the right bank of the Orinoco, is of sedimentary origin. Although it was not actually visited, the sedimentary nature of the

[1] Holdridge, Desmond. Notes on an exploratory journey in southeastern Venezuela. Geogr. Rev. **21**: 373–378. 1931.

[2] Andre, E. A naturalist in the Guianas. New York, 1904. p. 218.

[3] Rice, H. The Rio Branco, Uraricuera, and Parima. Geogr. Jour. **71**: nos. 2–4. 1928.

[4] Schomburgk, R. H. Reisen in Guiana und am Orinoko. Leipzig, 1841.

[5] Op. cit. 428.

rock was obvious. The stratification, quite plain to the naked eye, showed slight folding, but the beds were comparatively flat.

To these might be added the observations of Koch-Grünberg, Passarge, and others, whose contribution to the geography of the Guayana Highlands do not add particularly to the specific problem of sandstone distribution. Koch's description of the upper Rio Ventuari extends the known boundary of sandstone well to the north of Duida, but makes no vital change in the other observations. North of the Orinoco and to the west, the extent of former sandstone distribution is not known. The close affinity of the majority of Roraima and Duida birds to those of the Andes[1] indicates strongly a former connecting link to this mountain system, but whether north, west, or both is a matter of future investigation.

The presence of sandstones and quartzites over this wide area, the general similarity of the red and white conglomeratic sandstones and shales, the apparently increasing metamorphism in proximity to both eastern and western flanks of the Parima axis, and the resumption of approximately horizontally bedded mountain masses at a distance from the Parimas, suggests a correlation of the Duida sediments with the Roraima series. At some time since the deposition of the sandstone, orographic disturbance, possibly accompanied by igneous intrusions (e.g. Schomburgk's observations) took place along the axis of the Parimas.

The best evidence for the age of the Roraima sediments is well summed up by Liddle.[2] He states that "the age of the Roraima series is not definitely known. It bears, however, a striking lithologic similarity to sediments of Lower Cretaceous age, which are exposed in the Coast Range, in the Venezuelan Andes, and in the Sierra de Perija. Especially is the resemblance between this series and the Barranquin formation of northeastern Venezuela noticeable, and it is with this formation that the correlation is made."

If the Duida sandstones be of equivalent age to the Roraima series, a somewhat more complex history must be given to the Guayana Highlands.

Liddle[3] states that "Since the deposition of the Roraima series there seems to have been no noticeable movement of the Guayana Highlands. . . . So far as indicated by the rocks which compose it, this old land area has been relatively stable since earliest geologic time. It has been submerged probably not more than twice—once during the Paleozoic when the

[1] Chapman, Frank M. Problems of the Roraima-Duida region as presented by the bird life. Geogr. Rev. 21: 363–372. 1931.

[2] Liddle, R. A. The geology of Venezuela and Trinidad, 123, 124. Fort Worth, Texas, 1928.

[3] Op. cit. 124.

Imataca series was deposited and once during early Cretaceous time when probably the Roraima series was laid down."

If the sandstones of Duida are correlatable with the Roraima series, which from the point of view of distribution and lithologic similarity seems quite likely, one more chapter is added to their post-Cretaceous history. Following the deposition of the sediments, the orographic movement took place along the Parima axis as stated above. Following this, a long period of peneplanation truncated the folded sediments of the central Parima area. Presumably the land at a distance from the folded area lay at comparatively low altitude, although it is impossible to state the amount of material removed from its surface during the formation of the peneplane. Since then, broad uplift over the entire region has occurred, post-peneplane faulting has taken place in the region of previous mountain-making. Weathering and erosion have done their share in carving out the flat-lying and folded sediments into their present expression. It seems logical to believe that the faulting, exhibited to such a marked degree on Cerro Duida, must have commenced at least in late Tertiary time. Low scarps in the talus parallel to the southwestern front of Duida give indication of probable faulting in recent times.

The purpose of giving these observations is not to state a definite history, but to point out what seems to be a possible correlation and history of this widespread and little known sandstone formation. If this serves as a basis for future observations, it serves its purpose.

IV. ASPECTS OF VEGETATION AND PLANT ASSOCIATIONS[1]

In discussing the areas of plant associations of the Duida region, such a wealth of distinct local environments must be dealt with that it has been thought advisable at the beginning to draw up a table to show environmental subdivisions, together with a base map upon which their geographical position may be plotted. It is hoped in this way that they may be made more easily intelligible. Each division will be briefly characterized and some of the more noteworthy plants mentioned (pl. 17–21).

- Lowlands
  - Esmeralda area
    - Riverside
    - Flood (igapo) forest
    - Savana
      - Dry phase
      - Swampy phase
    - Ridge
  - Grand Savana
    - Dry outwash from talus slopes
    - Swampy phase
  - Other open areas
    - Grass savana
    - Tree savana
    - Caña brava thickets
  - Forested areas
    - Unburned phase
    - Replacement phase

[1] By G. H. H. Tate.

- Slopes
  - Talus portion
    - Drier ridge tops
    - Moist valleys
  - Steep portion
    - Cloud forest
    - Crest slope and Bromeliad zone[1]
- Plateau
  - Greater part of area: Soils of greater or less thickness of pure humus (the generally prevalent condition), occurring as very humid phase (at edge of cliffs) or moderately humid phase (remote from cliffs)
    - Crests
      - Dry phase
      - Swampy phase
    - Slopes
    - Valleys
    - Stream beds and banks
    - Replacement flora after fire
  - Restricted area at center: Soils compacted and formed mainly of iron laterite, both hematite and limonite being present (known only near the Savana Hills near the center of the plateau, not exceedingly humid)
    - Crest
    - Slope
    - Rocky
      - Swamp phase
      - Dry phase
    - Wooded
    - Stream

The Duida region is at once divisible into lowlands, slopes, and plateau, each division manifesting in turn a greater or less number of subdivisions, as follows:

ESMERALDA AREA

The vicinity of Esmeralda is a rather extensive savana[2] running back from the Orinoco River half a mile and with a length of about a mile, across which, about 100 feet above the plain, the low Esmeralda Ridge extends, formed of the shattered quartzite rock which Schomburgk mistook for granite. At either side of the savana adjoining the river and to the northwest it is bounded by the Orinoco flood forest, and northeast and east by normal lowland forest. Much of the land, which rolls gently, is well drained sandy soil. It is clothed by grasses, of the genera *Aristida*, *Andropogon*, and *Leptocoryphium*, among which grow the savana tree *Byrsonima crassifolia*, the pink-flowered herbaceous melastome *Pterogastra major*, the gentian *Chelonanthus* and the milkwort *Polygala hygrophila*. Behind the ridge and east and west of Esmeralda, the swampy part of the savana is drained by several streams along which small "morichales" are formed together with their characteristic floral communities. These swamps, the second of which contains no moriche palms, drain from the side of the ridge toward the Orinoco east of the palm swamp (See map). The sandy marsh farther east has scattered moriches and many interesting plants, among which are groups of the large pink-flowered *Rhynchanthera*

[1] So named because of the extensive development of the giant Bromeliad, *Brocchinia* sp.

[2] This spelling has been consistently followed by Mr. Tate in accordance with the practice of the American Geographical Society.

grandiflora, numbers of sedges of the genera *Lagenocarpus*, *Cyperus*, *Psilocarya*, and *Eleocharis*, the little palm *Lepidocaryum*, the blue-flowered *Abolboda macrostachya*, and the new *Monotrema xyridoides*. Among smaller plants are a number of species of *Eriocaulaceae*, *Lentibulariaceae*, *Burmanniaceae*, *Droseraceae*, and *Lycopodiaceae*. This swamp merges with East Lake, along whose margin are found two peculiar plants, one a mauve-flowered plant of the *Scrophulariaceae*, *Naiadothrix reflexa*, its tiny leaves dissected like miniature chamomile leaves, the other *Mayaca Sellowiana*, growing in patches, erect, with tiny whorled leaves that make the plant resemble *Polytrichum*.

Speaking generally, the flora of the savana, whether due to cattle feeding there or to repeated burning, seems much impoverished.

Considering now Esmeralda Ridge, visited by Richard Spruce in December, 1853, the grasslands of the savana often sweep up almost to the crest, but among the broken rocks grow not only a number of trees and bushes but also numerous herbs. Among the former may be mentioned *Clusia columnaris*, the odd-looking *Qualea esmeraldae*, the Berberis-like melastome *Acanthella conferta* with its flaming orange flowers, and species of *Cassia* and *Byrsonima*. The latter include the beautiful tall white and yellow orchid *Sobralia liliastrum*, *Smilax Benthamiana*, *Mandevilla mollissima*, and species of *Anthurium* and *Pitcairnia*. Under the shelter of the rocks live the ferns *Oleandra hirta*, *Anemia buniifolia*, and *Lindsaya*, together with a number of mosses, liverworts and lichens. On the crest of the ridge one or two swampy pans occur where *Xyris savannensis* and *Syngonanthus gracilis* grow.

The flood forest, while showing no unusual features, varies from densely tangled vine-covered forest to relatively open park-like woods (the tree savanas of Esmeralda) bordering areas permanently covered by water. In many places huge growths of "razor-grass" (*Scleria* sp.) spring up at the commencement of the dry season and cover many of the lower trees. In the river itself certain floating plants, *Piaropus crassipes* with air-filled leaf-bases and others, grow outward over the water from the partly submerged branches of the igapo.

GRAND SAVANA

This prairie, which as previously stated is the large area of savana adjoining the southern tip of Duida, appeared when discovered to be in virgin condition. As we crossed the lower swampy part adjoining the forest near Esmeralda it presented a lovely sight—fresh and moist after the rains, its verdant surface was broken here and there by low flowering bushes and taller stands of cyclanths. The shrubby growth included the red-berried

Humiria floribunda spathulata, the low straggly *Heteropterys oblongifolia*, and very commonly *Qualea esmeraldae*, with its large whitish, somewhat papilionaceous flowers. Of lower plants, I may mention the bromeliad *Brocchinia prismatica*, a pretty yellow-flowered orchid, *Xyris subglabrata* with orange-yellow flowers, as well as a host of grasses, sedges, *Eriocaulaceae*, and *Xyridaceae*. From this lower part the ground swept gradually up to the talus slope of the mountain. The dry portion, across which several little palm-fringed streams meandered, was much less varied as to vegetation. Here a *Cuscuta* grew commonly as well as many of the plants of the dry parts of Esmeralda Savana. A tongue of the upper savana, becoming rather bushy in places and dividing the talus slope forest of Monkey Valley from that to the northeast, reached up the talus to nearly 1000 feet on Burned Mountain. On its slopes a pretty white-flowered melastomaceous bush, *Acisanthera erecta*, was abundant.

LONG GRASS SAVANAS

Only one example of this type, named New Savana, was encountered. Our trail crossed it between Grand Savana and Middle Camp. Grass usually four, and in no place less than two feet high, clothed part of it. A very few scattered savana trees, including *Byrsonima* and two Dilleniaceae, were present. Soon after its discovery the Indians burned off the grass. This they did later to Grand Savana also.

TREE SAVANAS

This name we applied particularly to an environment between Middle Camp and Base River, but a rather similar example was found on the ridge just east of Foothills Camp, where in addition the orchid (*Sobralia*) of Esmeralda Ridge grew profusely. The ground was uneven, stony, and generally covered with crisp harsh grass about a foot in height. Tree Savanas was separated into small grassy areas by scattered groups and belts of low, sometimes gnarled trees, including *Clusia columnaris* and *Protium guianense*, and bushes such as *Humiria balsamifera*, *Humiria savannarum*, *Retiniphyllum Schomburgkii*, and the melastomes *Macairea pachyphylla*, *Miconia stenostachya*, and *Ernestia tenella*. In the shade of the trees little spaces of ground carpeted with *Selaginella radiata* and the curious-looking fern with fingered fronds, *Actinostachys pennula*, could be found. More rarely the tall purple orchid *Epistephium parviflorum* and the vine-like *Blepharodon venezuelense* were noted here.

CAÑA BRAVA THICKETS

Although found only along the brook at the western edge of New Savana, this densely matted thicket of Caña Brava sedge eight feet

deep may well be considered as constituting a distinct association area. Tall moriche palms were scattered through the canebrake.[1]

LOWLAND FORESTED AREA

The lowland or Amazonian forest in the Duida region may be thought of as a matrix which surrounds each one of the savanas of the district. Occasionally narrow tongues of this forest push out into the savanas. The igapo forest of the river bank passes gradually over into the drained forest, certain parts of which, having no positive direction of run-off, have developed an insequent system of small trenches surrounding the base of the larger trees into which water drains. The water in these depressions, although practically stagnant, seems gradually to find its way out to definite water-courses. In general, however, the forest has a well defined drainage system comprising the numerous small streams which cross from the talus slope of Duida to the Orinoco. The soil, which is sandy, overlies in places quartzite conglomerates perhaps derived from the Duida beds of quartzite. Its humus content, as may be expected, is high.

From the botanical standpoint, the forest is perhaps best distinguished from other Amazonian forests on account of the relative abundance of magnificent palms. A phase in which palms quite predominated was met between Middle Camp and Tree Savana. Here the most striking kind of palm has graceful twenty-foot leaves and appears at first sight to be stemless, for the leaves start from the ground and arch over. Individuals of this type are really young, and about five young are seen for every adult tree with trunk. Trees which are relatively common are the "moura," three species of Annonaceae, *Bocagea multiflora*, *Aberemoa asterotricha*, and *Anaxagorea acuminata*, whose bark is used for making ropes and fibers, and the cigarette tree, whose inner bark, split into thin layers, is employed by the natives for wrapping cigarettes. Enormous clusias, bignonias, Apocynaceous vines, etc., drop their flowers in due course as their months of flowering pass by. The average diameter of the trees (not palms) is from twelve to fifteen inches. Every fifty yards or so a giant of the forest with trunk thickness of three or four feet is met. At Middle Camp one could as a rule see for only about twenty feet through this forest. Since the expedition was not equipped for collecting the flowers and fruit of the great forest trees, anything secured was obtained incidentally through the breaking down of limbs or making of clearings.

Along the lower part of Base River the forest grew very tall, with a rather open but high undergrowth of *Heliconia*, etc. rooted upon the silts

[1] The name caña brava is generally applied in Latin America to tall grasses with the aspect of sugar cane.—H.A.G.

and bordering flood plains built up by the river. Nearer the mountain, as the ground became rougher and more tilted, the lowland forest gave place imperceptibly to the forest of the talus slope which had characteristics of its own.

REPLACEMENT VEGETATION OF LOWLAND FOREST

Wherever the woods had been burned, and this had occurred in many places, a wealth of succulent plants, mainly Scitaminales but also *Cecropia*, *Pteris*, and thorny "cariñoso" (*Solanum*), had quickly grown up and covered the welter of half-burned trunks and roots. At Middle Camp solid walls of this herbage might be seen, after it had been cut and piled up out of the way by the road makers. In some places we came upon what may have been a later phase of replacement, bushy growth swamped by masses of vines, Convolvulaceae, and a pleasant tasting *Passiflora* (named locally Paujcha). The largest burned area extended from around Middle Camp up a great part of the talus slope and precipitous part of one of the southern promontories called by us Burned Mountain and, as found subsequently, actually reached the summit of the plateau.

TALUS SLOPE FOREST

The forest of the lower parts of the Duida slope, although intergrading with that of the lowlands, contains numerous elements which are rare or absent from the latter, such as the taraña or gum used by the Indians for lighting fires and making torches and false balata or "pulga negra," a huge latex-bearing tree whose balata however is very inferior. In spite of the fact that many species drop out as in turn others appear, this talus forest may be thought of as reaching far up the southeast scarp toward the cliff-encircled heads of the ravines. It does not, however, ascend the steep slopes such as Agüita. The lower part of the forest is represented by the flora present at Foothills Camp (800 feet) and Monkey Valley Camp (750 feet), the upper part by Caño Seco Camp (1800 feet). As with the lowland forest, the arboreal flora of the talus slope and steep slope forests is but poorly collected, the plants secured on the slopes being mainly herbs and bushes.

STEEP SLOPE FOREST

These woods, whose separation from the talus forest may be considered arbitrary, in my conception are confined to the steep sides of the great ravines below the crest slopes of the promontory, and while controlled rather by the factor of exposure than by that of altitude may be regarded as forming a definite belt separating the uppermost talus forest from the vegetation of the crest slopes and summit. It is met again toward the de-

pressed center of the plateau about Savana Hills, which it seems to have reached from the exterior by way of the gorge of the Caño Negro, but here it is considerably modified by the addition of a number of plants whose affinities are with the plateau flora. This forest, on the exterior scarps, occurs typically at Agüita (2300 feet) and upward as far as the "Bromeliad zone" (3800 feet), marking the beginning of the crest slope of First Ridge. Its trees, though tall, are smaller and slenderer than the immense trees of the talus forest, and in large measure are of different species. At its upper edge they dwindle still more in size until at the less steep, though much exposed crest slope, they appear definitely stunted. This place also marks the lower limit of such plateau trees as *Archytaea multiflora* and *Bonnetia longifolia*. On rocks in exposed places on this crest the flame-flowered orchid *Hexisea bidentata* grows. Among lesser vegetation of the Agüita forest may be mentioned *Smilax floribunda* and especially two gesneriaceous plants, *Episcia cordata* with variegated leaves and tubular mauve flowers and *E. cuneata* with small white flowers resembling violets, both of which were taken at Agüita growing on a rock-face down on which water seeped.

Considering now the same class of woods at Savana Hills, we note its presence in three separate minor environments: along the south side of the gorge of the Caño Negro, where the fern *Elaphoglossum latifolium* is plentiful; in a pocket on the southern slope of Savana Hills close to camp, where a number of interesting plants, including *Saxo-Fridericia regalis*, the great arum *Philodendron*, the composite tree *Stenopadus talaumifolius*, and orchids of the genera *Pleurothallis*, *Lepanthes*, *Maxillaria*, *Epidendrum*, *Scaphyglottis*, and *Sobralia*, grow; and, in a more open phase, on the north slope of the same in a valley named Laterite Valley. These patches of forest seem to differ slightly among themselves, that by the camp being especially rich in the terrestrial aroid.

THE PLATEAU

The greater part of the folded plateau constituting the mountain-summit has a soil covering of almost pure humus, but at the center there appears to have been a downwarping of the tableland combined with general fracture of the strata in a southwest-northeast direction, resulting in soil modification. By some means, not yet ascertained, this transverse cracking of the strata has been accompanied by a concentration of iron, manifested by the iron laterite soil of Savana Hills Ridge. The ridge, together with the deep canyon of the Caño Negro, cutting directly across the prevailing folded structure of the mountain and diverting the drainage, seems to lie parallel to this line of fracture. Some indication of the changed nature of the soil is also noticeable at Brocchinia Hills, just south of the Caño

Negro. Discussion of the floral regions of the plateau will deal first with the areas of humic soil and later the more local conditions found at the center of the tableland.

In the humus soil division two sets of climatic modifiers combine to produce the highly varied and complex results observable. On the one hand we see crest, slope, and trough repeated serially as we pass from northeast to southwest across the ridges. The scarp as a whole, however, attains more and more absolute altitude, so that from 6300 feet, the height of the crest over which we made the ascent, an altitude of 7800 feet is reached in the extreme southwest at High Point. The second set of factors operate at right angles, northwest to southeast, to the above, and are two: decreasing altitude brought about by tilting of the tableland as a whole away from the cliffs, and diminishing humidity due to greater distance from the scarp-face up which clouds continually drift. A glance at the map will illustrate. Points of maximum humidity are met in the troughs of valleys at the edge of the precipices and conversely the crests of ridges near the center of the plateau are the driest. It may be emphasized here that since exposure-vegetation is found far down the ridges and sheltered floras reach far up valleys—to such a degree that the lowest range of the former may be far below the highest range of the latter—obviously the factor of exposure (or shelter) is vastly more influential than the factor of altitude above sea-level.

VEGETATION OF THE CRESTS OF THE PLATEAU

Speaking broadly, the crest ridges of Duida, each one of which includes several minor phases, are much alike. In cases where the crest is low and broad the slope vegetation (see beyond) passes over it unaltered. When the crest is high and partly or wholly denuded of soil a specialized crest vegetation is developed and this vegetation extends far down (to 4000 feet) on the exposed knife-edges of the promontories.

Perhaps the most usual association on exposed crests is a low, tightly packed, cushiony growth of the pitcher-plant *Heliamphora Tatei* or *Navia*, or wiry growths of assorted shrubs. These are often more or less segregated, here an area of pitcher-plants, there a carpet of heathy or bromeliaceous growth. Scattered through this are a great variety of plants, of which but a few, *Odontoglossum*, *Zygopetalum Tatei*, *Maxillaria*, *Schefflera umbellata*, *Tibouchina fraterna*, *Retiniphyllum erythranthum*, *Conomorpha duidae*, and *Epidendrum inconstans*, may be cited. If the rock is nearly bare, plants growing about it become correspondingly reduced; on the other hand slight dips or sheltered pockets contain all sorts of shrubs, ferns and dwarfed trees, such as *Meriania duidae*, *Abolboda Sceptrum*, *Stegolep-*

is guianensis, *Dendrophthora roraimae*, *Graffenrieda polymera*, *Pterozonium Tatei*, etc. The pockets marking the junction of steep slope forest of the escarpment with the crest vegetation are especially varied and interesting. Here for instance, besides the heavy growth of *Brocchinia* sp., often with the blue-flowered *Orchyllium Humboldtii* growing in its leaf-bases, are found the yellow-flowered shrub *Tateanthus duidae*, *Anthurium quinquenervium*, *Eupatorium Tatei*, etc. The "Bromeliad zone" on the promontories, which divides crest vegetation from steep slope forest, I regard as an extension of the slope vegetation of the ridges of the plateau, in which *Brocchinia* is a very important element. Minor developments on the crest are little swampy depressions containing *Sphagnum*, *Abolboda Sceptrum*, *Maxillaria*, *Heliamphora*, *Stegolepis*, and various Lentibulariaceae, sedges, xyrids, and Eriocaulaceae.

SLOPE VEGETATION OF THE RIDGES OF THE PLATEAU

Once more several phases are observable. Near the precipice the slope flora changes from deep wiry brush adjoining the crest progressively to taller and stouter, more succulent and moss-hung vegetation as the heads of the trough-valleys are reached. These changes seem to be dependent primarily on the degree of exposure. Again, as one traces the slope vegetation along the ridge and away from the cliffs, it once more becomes larger, but this time the lessened rainfall tends to produce a small-tree type of woods which grows straighter and is less hung with mosses and liverworts, though still filled with underbrush and Bromeliads. The brushy growth comprises a great wealth of species of *Ternstroemia*, *Psychotria*, *Tyleria*, *Bonnetia*, *Stenopadus*, *Grammadenia*, *Cyrilla*, *Duidania*, *Conomorpha*, *Ilex*, *Purdiaea*, *Mikania*, *Oedematopus*, *Chalepophyllum*, *Clusia*, *Schefflera*, *Phoradendron*, *Didymopanax*, *Phthirusa*, *Weinmannia*, and others.

The station at High Point Camp was located by the nearest water—a mere trickle—and was some 400 feet below Peak 7. The ascent crossed two small ridges called respectively first and second Ridges of Peak 7. These are parted by two small valleys containing Valley Head forest, with a reduced undergrowth of *Brocchinia* sp. On the exterior or scarp faces of the peak the plants still show the effects of exposure, but the numerous pockets and crevices afford ample shelter locally in which profuse vegetation is found.

On or closely adjoining the top of the peak occur *Thibaudia truncata*, *Mycerinus sclerophyllus*, *Monnina duidae*, *Didymopanax rugosum* and *reticulatum*, *Clusia pachyphylla*, *Gaylussacia cacuminis*, *Gongylolepis glaberrima*, *Phyllanthus duidae*, *Burmannia foliosa*, *Ditassa duidae*, *Podocarpus roraimae*, as well as *Purdiaea*, *Grammadenia*, *Ternstroemia*, *Gongylo-*

lepis, *Cyrilla*, *Ilex*, *Graffenrieda*, *Psychotria*, *Weinmannia*, etc. The herbaceous plants of the crest are *Heliamphora Macdonaldae*, which forms a firm cushion over the very peak of the mountain, the orchids *Epidendrum carnosum*, *E. inconstans*, and *Eriopsis grandibulbosa*, and others such as *Tofieldia*, Bromeliads, *Blechnum*, *Alsophila* (in protected places) and various xyrids.

Forest fire from below had ascended and burned a portion of the plateau vegetation of the headland named Burned Mountain (Ridges 21 and 22). A very limited replacement flora, composed of *Polytrichum antillarum*, *Funaria calvescens*, *Nephrolepis cordifolia*, and *Mikania duidensis* was observed.

FOREST OF THE VALLEYS OF THE PLATEAU

In the troughs of these valleys and the lower part of the slope forest we see another of the extraordinary vegetational features of the Duida plateau. Tree-trunks sprawl semi-recumbent or entirely so along the the ground for twenty feet before raising their branches to the forest ceiling. In some cases a foot of humus soil buries them. They appear extremely slow of growth, being thick and gnarled, with branches short and blunt and leaves often in terminal whorls among which large (usually pink) flowers open. The undergrowth is dense, brittle, and often succulent, containing *Brocchinia*, *Rapatea*, *Heliamphora*, ferns, etc., and the lower parts of the entire forest are buried in enormous growths of reeking hepatics, mosses and lichens. Following one of these valleys (Central Valley) from the cliff-edge (Valley-head Camp) northwest, the trees, except in the deepest parts, tend as with the slope forest to be less often prone and by reason of drier conditions to be less hung with moss. Even at Central Camp, three miles from the scarp, where the clearing of the site involved removal of many bizarre trees such as *Tyleria*, prone tree-trunks were the rule. It is my opinion that in many cases the prostrate condition of the tree-trunks is brought about by the instability of the humus soil, the trees literally falling over in it at some time of their growth and then growing up again. The soil yields to the tread and literally quivers for feet around if one jumps upon it. Camp fires burn their way down into it. Outstanding forms at Central Camp were *Byrsonima cretacea*, *Psychotria campylopoda*, *Archytaea multiflora*, *Bonnetia tristyla*, *B. longifolia* and *B. crassa*, *Tyleria floribunda*, *T. spathulata*, and *Retiniphyllum erythranthum*, and near the brook *Diacidia vestita*. The forests of the valleys and lower slopes of the ridges, as they near the lower levels at the center of the plateau, gradually transform themselves into the steep-slope woods already described at the Caño Negro. Regarding the upper ends of these same valleys, in one or two of the smaller and higher ones (as at Ridge 15 and High Point) the

gnarled trees are seen to become smaller and smaller and finally to cease altogether without reaching the edge of the cliffs, but in Central Valley and at Desfiladero Camp the valley forest terminates only at the brink of the precipice.

In each valley a stream originates. Deep and narrow at its source, the water colored brown by the prevailing humus, these streams farther down their course form a series of deep rock-pools or even quite high falls (i.e. Vegas Falls). Since they are subject to great freshets their vegetation is necessarily very firmly anchored and wiry. Frequently the entire rocky bed is covered by the strongly modified *Paepalanthus capillaceus proliferus.* The banks are lined by *Luxemburgia duidae*, *Duidaea pinifolia*, which resembles a dwarfed spruce, *Ravenia linearis*, and the wiry little melastome *Macairea linearis.* The greater part of the stream beyond reach of flood is overhung by branches of the valley forest. Here and there small deposits of sand relatively low in humus may be noted, where *Perama scaposa* grows. This species is found also high on ridges, as at Peak 7.

Mention should be made of parts of stream beds which have very rocky sides, such as at the humid Provisional Camp and Central Camp. Here a multitude of plants occur, such as mosses and hepatics, *Selaginella microdonta*, *Xyris duidensis*, various Lentibulariaceae, *Poteranthera duidae*, *Hymenophyllum*, *Tofieldia Schomburgkiana*, and *Pterozonium.*

SAVANA HILLS, CENTER OF DUIDA PLATEAU

As already explained, the fundamental distinction at Savana Hills is the development of a laterite soil in place of a humus soil. Savana Hills, unfortunately, is found to be rather a misnomer. When first seen (from Ridge 25 ten miles away) the ridge gave the impression of being savana-covered. Much later it was found to be clothed mainly by bromeliads with tough spiny leaves, and to have relatively little grass. Lying almost at the center of the plateau this station was reached by a trail from Central Camp which passed by Vegas Falls and Brocchinia Hills, descended the forest-clad southern slope of the deep gorge of the Caño Negro, and, crossing the stream by a log bridge, climbed the steep, dry, sandy northern bank to the camp.

The ridge, generally speaking, is formed of a series of large knolls several hundred feet above the gorge. The crest and much of the slopes are dry and clad scantily with brush and shrubs. In a pocket through which a tiny brook passes close by camp the steep-slope forest, already mentioned, is developed, and on the opposite or northern side of the ridge the more open woods of Laterite Valley. Broadly speaking the upper, savana-appearing slopes are chiefly covered with bromeliads, the lower parts border-

ing the gorge of the Negro being lightly wooded with *Tyleria*. The northern side of the gorge produces a number of local plants, *Leitgebia guianensis*, *Xyris stenophylloides*, *tenella*, and *duidensis*, *Panicum obovatum*, *Selaginella scalariformis*, *Duidaea Tatei*, and *Ledothamnus parviflorus*. Cracks in the bare rock in the bottom by the river give anchorage to still others, including *Duidaea pinifolia* and flood-torn specimens of the remarkable *Barbacenia Alexandrinae*.

Probably the crest of the ridge, which is without question the headquarters of *Barbacenia Alexandrinae*, produces the greater part of the plants indigenous to Savana Hills, while the slopes, although provided with a most interesting flora, are a transitional type between the flora of laterite soil crest and that of the remainder of the plateau. Besides *Barbacenia*, the crest of Savana Hills produces shrubs of *Tibouchina fraterna*, *Clusia rotundifolia*, *Remigia laevifolia*, *Pagamea montana*, *Myrcia sylvatica*, *Macairea rigida*, *Ouratea* sp., *Ilex duidae*, *Graffenrieda ovalifolia*, *Byrsonima bracteolaris*, *Conomorpha lepidota*, and the crimson-flowered *Bejaria variabilis*. Most of these plants are scattered along the ridge, being only slightly massed in the depressions. The low growth is composed mainly of spiny-leaved bromeliads with occasional specimens of *Calolisianthus Tatei*, *Chelonanthus pyriformis*, *Metastelma mirifolium*, *Calea abelioides*, *Stenophyllus*, *Everhardia*, and *Echinolaena inflexa*.

On the southern slope, swampy ground by the camp produces small trees, *Clusia*, *Tyleria*, etc.; shrubs, including *Duidaea rubriceps* (the buds resembling small cones), *Chalepophyllum latifolium*, *Ilex retusa*, the mucilaginous *Macairea lanata* and *Tococa oligantha;* and herbaceous plants, *Lindsaya stricta* and *pendula*, *Stegolepis pungens* and *linearis*, *Epidendrum*, various sedges, *Leiothrix turbinata*, *Panicum curvifolium*, *Xyris*, *Amphiphyllum rigidum*, the tubular growths of *Brocchinia reducta* (also on Brocchinia Hills), and the magnificent pitcher-plants, *Heliamphora Tyleri*.

Just east of this swampy part the rock is to a great extent exposed. Here the aroid *Philodendron* and slender-leaved spinous bromeliads grow. The dry slope below the crest but above camp level bears scattered bushes of *Thibaudia glandulosa*, *Humiria floribunda montana*, *Retiniphyllum*, and the tree *Couma utilis* quite loaded with edible fruit, as well as bromeliads, sedges and apocynaceous vines.

V. LIST OF PLANTS COLLECTED, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES

HYMENOPHYLLACEAE[1]

Lowland Species

TRICHOMANES PINNATUM Hedw. River-bank at Foothills Camp, 750 ft., *397;* a common and heteromorphous species found throughout tropical America.

TRICHOMANES CRISPUM L. Foothills Camp, 750 ft., *379;* a widespread and variable species in tropical America.

Species of Mount Duida

HYMENOPHYLLUM SERICEUM Sw. South bank of Caño Negro, Savanna Hills, 4400 ft., *852;* a species of general distribution in tropical America.

HYMENOPHYLLUM CRISPUM HBK. On tree trunk, Central Camp, 4800 ft., *551;* south bank of Caño Negro, Savanna Hills, 4400 ft., *1036;* a plant of wide distribution in tropical America. The Mt. Duida specimens are more delicate and feathery than typical material. With *1036* is mixed a fragment which can probably be referred to *Hymenophyllum brevifrons* Kze., a diminutive species sparingly distributed from Cuba to Brazil.

TRICHOMANES PLUMOSUM Kze. Among rocks in woods, 50 feet below summit of Peak 7, 7050 ft., *663;* an Andean species.

TRICHOMANES CRINITUM Sw. Under a sloping tree trunk, Ridge 25, 5500–6000 ft., *444*. Distribution, tropical America. The present specimen is less pubescent than West Indian material. Possibly more than one species is represented among the material referred here.

TRICHOMANES ACCEDENS Pr. In brook-bed under ledges, slopes of Ridge 25, 5500–6000 ft., *445*. In referring the present specimen to *T. accedens*, some latitude must be allowed in regard to the shape of the pinnae, which in the illustration of Hooker and Greville (Ic. Fil. t. 12. 1827) are adnate on the rachis, and in Tate's plant are more or less contracted at the base. Quite probably a careful study of this difficult and confused group will establish the specific identity of many additional specimens. The range of the true *T. accedens* is uncertain, it probably being rare in the southern West Indies and the north coast of the continent.

CYATHEACEAE[1]

Lowland Species

HEMITELIA MULTIFLORA (Sm.) R. Br. San Gabriel, Rio Negro, Brazil, *140*. Distribution, throughout tropical America.

[1] By Albert C. Smith.

ALSOPHILA BLECHNOIDES (Rich.) Hook. Forest at Middle Camp, Esmeralda, *352;* woods at Foothills Camp, 750 ft., *377*. A well-marked species of wide distribution in tropical America.

Species of Mount Duida

CYATHEA SCHANSCHIN Mart. Plant 8 ft. tall, 50 ft. below summit of Peak 7, 7050 ft., *668;* plant 3 ft. tall, Agüita Slope, 3800 ft., *865*. The Mt. Duida specimens have somewhat smaller fronds than typical material of this widespread species.

HEMITELIA MACROSORA (Baker) Jenm. Camp Woods, Savanna Hills, 4400 ft., *849*. Characterized by long, pendulous, much-divided fronds. Previously known only from Mt. Roraima.

The following specimens were not referred; *402, 451, 626*, material insufficient for description; probably *Alsophila* or possibly *Hemitelia* and probably two new species are represented; *665*, juvenile, probably of this family.

POLYPODIACEAE[1]

Lowland species

OLEANDRA HIRTA Brack. Under rocks, summit of Esmeralda Ridge, *230;* a specimen which agrees perfectly with the type of *O. hirta*, with the single exception that the scales of the rhizome of our specimen are a trifle broader in proportion and have the margins faintly ciliate, a difference which hardly seems specific. Previously known only from the Organ Mountains of Brazil.

NEPHROLEPIS BISERRATA (Sw.) Schott. Manáos, *12*. Common in tropical America.

ASPLENIUM SERRATUM L. Woods at Foothills Camp, 750 ft., *384*. A widespread species in tropical America. The Mt. Duida specimen is somewhat smaller than typical material.

PITYROGRAMMA CALOMELAENA (L.) Link. Manáos, *13*. Common in tropical America.

ADIANTUM TOMENTOSUM Kl. Forest at Middle Camp, Esmeralda, *351*. Distribution infrequent, Guiana and Amazonian Brazil.

POLYPODIUM POLYPODIOIDES (L.) Hitchc. Epiphytic, woods at Foothills Camp, 750 ft., *380*. The fronds of this specimen are less scaly than those of typical material of the widespread species.

POLYPODIUM LINDBERGII Mett. Epiphytic, woods at Foothills Camp, 750 ft., *387*. Distribution Brazil and Paraguay.

No. *232*, a sterile specimen of *Lindsaya*, probably a simply pinnate form of *L. stricta* (Sw.) Dry., was not referred.

[1] By Albert C. Smith.

Species of Mount Duida

Oleandra articulata (Sw.) Presl. Agüita Slope, 3100 ft., *887*, *937*. A species of general distribution in the West Indies and northeastern South America, often known under the synonym of *O. nodosa* Presl.

Oleandra duidae A. C. Smith, sp. nov. Rhizomate ascendente, squamis lanceolatis attenuatis dense vestito; phyllopodiis sparsis longis; stipitibus olivaceis glabris; frondibus late linearis glabris, basi cuneatis, apice longe acuminatis, margine cartilagineis; costa superne canaliculata, glabra, nervis lateralibus simplicibus furcatisque; soris serie irregulari costae approximatis.

Rhizome scandent, 2–3 mm. in diameter, densely appressed-paleaceous, the scales imbricate, lance-attenuate, 6–8 mm. long, about 0.8 mm. broad, castaneous with lighter borders and base, faintly serrate and ciliate towards the long-acuminate apex; phyllopodia distant, 15–30 mm. long, glabrous or with a few scales at the base; stipes 3–6 cm. long, olivaceous, glabrous, grooved on the upper surface; lamina subcoriaceous, glabrous, broadly linear, 15–30 cm. long, 4–5 cm. broad near the middle, tapering in both directions, the base cuneate, the apex long-acuminate, the margins cartilaginous; costa olivaceous, slightly grooved above, elevated beneath, glabrous or deciduously scaly; veins single or in pairs, 13–16 per centimeter near the margin; sori few, 1–1.5 mm. broad, forming an irregular series 2–8 mm. from the costa; indusia orbicular-reniform, glabrous, entire.

At Central Camp, 4900 ft., *580*. This species allies itself to the group of *Oleandra* which has an ascending rather than a creeping rhizome, and especially to those species with a long phyllopodium. Of the two species of this affinity hitherto described, *O. guatemalensis* Maxon and *O. Lehmannii* Maxon, the Mt. Duida species more closely resembles the former. It seems to merit specific rank on the basis of its broad fronds, its large rhizome scales (about twice as long as those of *O. guatemalensis*), its large sori and its lack of costal scales at least in mature fronds.

Nephrolepis cordifolia (L.) Pr. Agüita, 3100 ft., *892;* burned-over ground on Burned Mountain, 6500 ft., *707*. A widely distributed and variable species.

Hymenophyllopsis. This remarkable genus was founded by Goebel[1] on a plant described by Baker[2] as *Hymenophyllum dejectum*. In discussing it Goebel points out that its relationship is with *Polypodiaceae* rather than *Hymenophyllaceae*. Its position within the family is uncertain, some morphological characters being primitive while others are derivative; it probably belongs with the tribe *Davallieae*. I place in this genus a fern from Mt.

[1] Flora N. F. **24**: 3. 1929.

[2] Hook, Ic. Pl. **17**: t. 1610. 1886.

Duida which agrees in details of structure with *H. dejecta*, although in general appearance it is very distinct. This fern may be known as:

Hymenophyllopsis asplenioides A. C. Smith, sp. nov, Rhizomate erecto, paleis longis dense vestito; stipitibus teretibus; frondibus bipinnatifidis, ovato-lanceolatis, rachidibus alatis; pinnis primariis alternis vel suboppositis, oblongo-lanceolatis; lobis alternis, obliquis, furcatis; venis obscuris; soris terminalibus in lobis, bi-indusiatis; indusiis persistentibus, ovatis.

Rhizome erect, ligneous, up to 2 cm. in length, stout (2–4 mm. in diameter), the younger part densely paleaceous, the scales delicate, stramineous, lanceolate from an oblong base, 1.8–2.5 mm. long, 0.2–0.4 mm. broad at the base, tapering to an acuminate tip, the cells in 6–10 irregular longitudinal series with pale delicate walls; fronds densely caespitose, the stipes terete, dark brown, stout (about 0.8 mm. in diameter), about 1 cm. long (rarely 2 cm.), deciduously paleaceous with scales similar to those of the rhizome, the lamina coriaceous, dull olivaceous, glabrous throughout, ovate-lanceolate, 7–12 cm. long, 2–3.5 cm. broad at the middle, tapering both ways, bipinnatifid, the primary rachis similar to the stipe in texture, winged throughout; pinnae 10–30 per side, lower ones subopposite, upper ones alternate, horizontal or slightly ascending, close (2 or 3 per centimeter), oblong-lanceolate, adnate at the base, up to 18 mm. long and 5 mm. broad (the lower ones reduced and irregularly palmate, the upper ones reduced as regards the number of divisions), the secondary rachis broadly winged, obscure; lobes alternate, oblique, 4 to 7 pairs below the dichotomously lobed apex, the basal ones sometimes irregularly palmate and sterile, sometimes dichotomously forked, in which case the lower fork is sterile, oblong, blunt, 3–4 mm. long, about 1 mm. broad, the upper fork fertile, oblong, about 0.5 mm. broad and 1 mm. long exclusive of the sorus, the upper lobes similar to the fertile branch of the lower lobes (the apical ones sterile); venation obscure, the veins following the branching of the pinnae; sori terminal on the lobes, bi-indusiate, the indusia of the same texture as the lamina, persistent, ovate, 1.2–2 mm. long. 1–1.5 mm. broad, fused on the outer margin which is often narrowly winged, inner margin usually free, entire, upper margin crenate with 4 or 5 irregular crenations not exceeding 0.15 mm. in length, the receptacle terminating a vein, lying between the indusia at their base, subhemisperical, somewhat flattened, about 0.3 mm. across the base, sporangia few (not more than 7 to a sorus), subsessile, obovoid, about 0.5 mm. on the long axis, cells of the annulus thick-walled, opaque, broad (especially those of the middle) (Pl. 22).

In brook-bed under ledges, slopes of Ridge 25, 5500–6000 ft., *439*. It is a species which in such characters as the rhizome, rhizome scales, texture, venation, and soral arrangement agrees with *H. dejecta* (Baker) Goebel. It differs in having the frond plane, much less pinnatisect, and with broader segments, and the stipe very short. Considerable variation is shown in the arrangement of sori; usually the indusia are joined along the

outer margin only, but rarely both margins are fused and occasionally both are free. Sometimes the soriferous vein is obscurely forked at the receptacle, one branch leading into the receptacle while the other leads a short distance up the wing at the fusion of the indusia, as though suggesting a sterile lobe. Superficially the present plant resembles *Asplenium theciferum* (HBK.) Mett. in the cutting of its pinnae.

LINDSAYA STRICTA (Sw.) Dry. Slopes of Ridge 25, 5500–6000 ft., *430;* moist slopes of Savanna Hills, 4400 ft., *777.* A species distributed throughout the South American tropics.

LINDSAYA CRENATA Kl. Agüita, 3100 ft., *893;* rare, known only from the southern part of British Guiana.

LINDSAYA FALCATA Dry. Agüita, 4000 ft., *904;* a species widespread in the American tropics, being abundant in Guiana.

LINDSAYA PENDULA Kl. Moist slopes of Savanna Hills, 4400 ft., *731;* a rare species previously found on savannas of British Guiana and northern Brazil, easily recognized by its small deflexed obcuneate pinnules.

BLECHNUM. Two species are represented, but both specimens are sterile. They are probably *B. acutum* (Desv.) Mett., first waterfall, 4900 ft., *577,* and *B. Boryanum* Schlecht., summit of Peak 7, 7100 ft., *650.*

Pterozonium cyclosorum A. C. Smith, sp. nov. Caudice subrepente, robusto, dense paleaceo; stipitibus dispersis, castaneis; frondibus coriaceis, oblongo-ovatis, glabris, basi cuneatis, apice rotundatis, margine integerrimo, plano; venis flabellatis, immersis; soris globosis vel oblongis, distinctis, ad venarum apicem productis.

Caudex subrepent, lignose, stout (4–6 mm. in diameter), densely paleaceous, the scales ferruginous, piliform, 4–6 mm. long, consisting of 15–25 cells; stipes about 15 to a plant, scattered (about 3 per centimeter of caudex), castaneous, 5–12 cm. long, slender, 3-angled, with a few minute piliform scales near the base; fronds coriaceous, oblong-ovate, 2.5–4 cm. long, 1.5–2 cm. broad, glabrous or faintly pubescent with minute black hairs (parasites?), the base cuneate, the apex rounded, the margins entire, cartilaginous, practically plane; venation flabellate, immersed, veins forking two or three times, 25–40 at their termination (1 mm. or slightly less from the margin); sori globose or oblong, seldom exceeding 1 mm. in length, distinct, produced at the apices of veins, the receptacles slightly sunken in the leaf tissue, round or elliptic; sporangia somewhat obconical, about 0.5 mm. on the long axis, cells of the annulus large, stalks short (0.2 mm. or less in length); paraphyses about 1 mm. long, of 5–10 cells.

In brook-bed under ledges, slopes of Ridge 25, 5500–6000 ft., *440.* It is a species resembling *P. cyclophyllum* (Baker) Diels, endemic to Mt. Roraima, from which it differs by having the caudex subrepent rather than erect, the stipes scattered rather than caespitose, the margins plane rather than revolute, and the sori round or short-elliptic, never linear.

Pterozonium Tatei A. C. Smith, sp. nov. Caudice erecto, lignoso, dense .leaceo; stipitibus caespitosis, castaneis; frondibus simplicibus, coriaceis, niformis, glabris, basi cordatis, apice rotundatis, margine plano vel recurvato, rrato; venis flabellatis, immersis; soris oblongo-linearibus, ad venarum apicem :oductis, leviter conjunctis, zonam angustam intramarginalem formantibus;)orangiis paraphysatis.

Caudex erect, lignose, 3–5 mm. in diameter, 3–5 cm. in length, densely aleaceous, the scales ferruginous, piliform, 5–9 mm. long, consisting of 6–12 :lls (the cells up to 1 mm. in length); stipes 10–15 to a plant, caespitose, casineous, 6–16 cm. long, slender, subterete or slightly 3-angled, glabrous or with few minute piliform scales near the base; fronds coriaceous, reniform, 12–17 ım. long, 20–30 mm. broad, glabrous or faintly pubescent above with minute lack hairs (parasites?), the base cordate, the outer edge round, the margin lane or slightly revolute, regularly serrate, the serrations triangular, about .5 mm. in length, often in pairs; venation flabellate, immersed, veins spreadıg from the base, forking 3 or 4 times, 50–90 at their termination, each ending a a serration; sori oblong-linear, 1–2 mm. long, produced at or near the apices f the veins, distinct or barely contiguous, forming a narrow band about 1 mm. rom the margin, the receptacles sunken in the leaf tissue; sporangia ellipsoid, .bout 0.5 mm. on the long axis, cells of the annulus with thick reddish-brown valls, stalks short (about 0.1 mm. in length); paraphyses dark red, of 4–6 :ells, forming a cluster of 10–25 at the base of each stalk, surrounding the porangium to half its length (Pl. 23).

In tufts, under cliffs, slopes of Ridge 25, 5500–6000 ft., *418*. This species ıppears close to *P. reniforme* (Mart.) Fée, a rare fern from Amazonian Brazil and Peru. However, the latter has the base of the lamina cuneate (rarely truncate), the serrations faint, and the sori arranged in a wide band several millimeters from the margin, while the Mt. Duida species has the base of the frond distinctly cordate, the serrations well-marked, and the sori arranged in a narrow band very close to the margin. In *P. reniforme* the sporangia are globose, with paraphyses longer in proportion than those described above.

Syngramma paraphysata A. C. Smith, sp. nov. Caudice erecto, paleis lanceolato-acuminatis nigrescentibus dense vestito; stipitibus caespitosis, castaneis, gracilibus; frondibus simplicibus, rigide coriaceis, ovato-lanceolatis, basi truncatis vel subcordatis, apice subacutis, margine integerrimo; venis pinnatis, furcatis prope costam vel simplicibus; soris linearibus, frondis faciem inferiorem praeter zonam marginalem et costalem occupantibus; sporangiis paraphysatis.

Rhizome erect, short, 3–5 mm. in diameter, densely paleaceous, the scales lanceolate-acuminate from an oblong base, nigrescent, 2–3 mm. long, about 0.5 mm. broad at the base, the cells opaque, in 6–10 longitudinal series with heavy dark brown partition walls; stipes densely caespitose, castaneous, 4–9

cm. long, slender (1 mm. in diameter), 3-angled, glabrous or sparsely paleaceous at the base; lamina thick-coriaceous, glabrous, often sulcate, ovate-lanceolate, 3.5–5.5 cm. long, 1.5–2.5 cm. broad, the base truncate or subcordate, the apex subacute, the margins entire, cartilaginous, plane or slightly revolute; venation pinnate, the costa shallowly grooved above, prominent beneath, the veins wide-spreading, forking from or near the costa (sometimes simple), raised above, plane or depressed beneath, about 8 per centimeter at their termination (less than 1 mm. from the margin); sori linear, 4–6 mm. long, borne on the veins midway between costa and margin, leaving a sterile band of 3–4 mm. along each side of the costa and of about 2 mm. along the margin; sporangia subglobose, about 0.4 mm. in diameter, cells of the annulus heavy-walled, stalks short (less than 1 mm. in length); paraphyses arising from the base of the stalk in clusters of 3 to 8, up to 0.7 mm. in length, of 6–9 cells.

In brook-bed under ledges, slopes of Ridge 25, 5500–6000 ft., *441*. It is a species belonging to the section *Austrogramme* Fournier, allied to *S. elaphoglossoides* (Baker) Diels and *S. brevifrons* A. C. Smith, both of which are endemic to Mt. Roraima. From both of these species it is distinguished by the shape of its fronds, its small nigrescent rhizome scales, its comparatively distant veins, the arrangement of its sori, and its paraphyses. The sori of *S. brevifrons* cover practically the entire lower surface of the lamina, of *S. elaphoglossoides* they leave a wide marginal sterile band, while of the present species they leave both a marginal and a costal band. Neither of the previously described species of this section have paraphyses; those of *S. paraphysata* are arranged in clusters, like those of *Pterozonium reniforme* and *P. Tatei*.

Psilogramme paucifolia A. C. Smith, sp. nov. Rhizomate elongato, parce paleaceo, paleis piliformibus; stipibus dispersis, multo elongatis; frondibus oblongo-linearibus vel lanceolatis, tripinnatisectis, rachidibus cum stipitibus pubescentibus; pinnis primariis alternis, oblongo-lanceolatis; pinnulis alternis, oblongis, extensis, pinnatisectis ad costam alatam, chartaceis, pallidis, glabris vel laxo hirsutis ad venis; segmentis obovatis, ad apicem divisis in duos vel tres lobos emarginatos; venulis subdichotomis; soris oblongis.

Rhizome elongate, repent, about 1.5 mm. in diameter, sparsely paleaceous, the scales reddish brown, piliform, 2–3 mm. long, consisting of 6 to 10 opaque cells; fronds scattered (about 1 per centimeter of rhizome), much elongated, 40–120 cm. long; stipe up to 40 cm. in length, about 1 mm. in diameter, becoming withered at the base, dark brown, subterete, deciduously pubescent with minute usually gland-tipped hairs (up to 0.2 mm. in length, of 1 to 3 cells); lamina linear-oblong or lanceolate, 20–80 cm. long, up to 11 cm. broad, tripinnatisect, the primary rachis similar to the stipe, more persistently pubescent; primary pinnae alternate, 15–20 per side (the lower ones deciduous), horizontal or slightly ascending, oblong-lanceolate, up to 6 cm. long and 2 cm. broad (the upper ones smaller), subequilateral, fully pinnate towards the base,

the secondary rachis above narrowly winged, sparsely clothed with glandular hairs (1–several-celled); pinnules alternate, oblong, spreading, 8 to 12 pairs below the blunt apex, pinnatisect to the winged costa, chartaceous, pale green, glabrous or laxly hirsute on the veins with scattered pale hairs; segments alternate, oblique, obovate from a cuneate base, 2 or 3 pairs below the blunt apex, cleft into 2 or 3 lobes, these bilobate at their tips; venation anadromous, veins of the pinnules subdichotomous, pale green, slightly raised on both surfaces, the ultimate branches terminating at the emarginate apices of the lobes; sori oblong (scanty on the present specimen), lying on the secondary veins of the pinnules midway between the costa and the apices of the segments; sporangia subglobose, about 0.25 mm. in diameter, short-stalked, nearly sessile.

Terrestrial on forest-covered slope, 50 feet below summit of Peak 7, 7050 ft., *677*. The present specimen is scantily fertile, so that mention of the sori is necessarily incomplete. It is allied to *P. hirta* (HBK.) Kuhn, from which it differs by having the segments more narrowly cut, the pubescence of the pinnules scantier, and the pubescence of the rachis obviously glandular. It is also close to *P. chiapensis* Maxon, a Mexican species which has the bases of the rhizome scales dilated. From both of these species *P. paucifolia* is distinguished by its uniformly shorter pubescence, its scattered rather than fasciculate stipes, and its tardily determinate fronds.

Histiopteris incisa (Thbg.) J. Sm. Agüita, 4000 ft., *914*. A widespread species; also known from Mt. Roraima.

Pteridium arachnoideum (Kaulf.) Maxon. Desfiladero, 6000 ft., *716*. Distribution, the mountains of tropical America.

Polypodium moniliforme Lag. Woods, Laterite Valley, Savanna Hills, 4400 ft., *766;* widely distributed in South America.

Polypodium kalbreyeri Baker. Central Camp, 4900 ft. *578*. Distribution, in mountainous Central America and eastward to Mt. Roraima. The present specimen agrees in particular with those from Mt. Roraima.

Polypodium capillare Desv. sens. lat. Epiphytic in woods, 50 feet below summit of Peak 7, 7050 ft., *675*. A species of general distribution, probably an aggregate.

Polypodium duale Maxon. Woods, Laterite Valley, Savanna Hills, 4400 ft., *765*. A species of wide distribution in tropical America, distinguished from others of its group by the delicate scales of the rhizome.

Polypodium strictissimum (Hook.) Hieron. Valley between Ridges 23B and 23C, *600*. A rare species from Colombia to Guiana, known also from Mt. Roraima (*im Thurn 351*). The scales of the rhizome have thick dark partition walls. The present specimen is referable to the forma *minor* of Hieronymus.

Polypodium nigrolimbatum (Spruce) Jenm. Valley beyond Ridge

23B, on tree trunks, 5950 ft., *480.* A rare fern of the section *Grammitis* Sw. (as genus), also found on Mt. Roraima.

Polypodium haplophlebicum A. C. Smith, sp. nov. Caudice suberecto, dense paleaceo; stipitibus subcaespitosis, brevibus; frondibus simplicibus, oblongo-linearibus, basi attenuatis, apice subacutis, margine plano et valde crasso; venis pinnatis, simplicibus; soris globosis vel ellipticis, venarum calcarem adscendentem occupantibus.

Epiphytic; rhizome suberect, slender (about 1 mm. in diameter), densely paleaceous on the young parts, the scales pale brown, lanceolate-acuminate from a slightly contracted base, 2–3 mm. long, about 0.3 mm. broad near the base, the cells small, irregularly arranged in about 10 longitudinal series (at the widest point) with delicate walls; fronds numerous, subcaespitose, the stipes subterete, short (less than 5 mm. in length), the lamina glabrous or sparingly pubescent with minute black hairs, oblong-linear, 3–5 cm. long, 3–4 mm. broad, the base narrowly attenuate, the apex subacute, the margins plane, entire, and thickened into a heavy dark brown border (uniformly 0.2 mm. broad); venation regular, the costa thickened, the veins somewhat conspicuous, plane above, slightly raised beneath, subopposite, straight, spreading, 7 or 8 pairs per centimeter, of the sterile portion simple, of the fertile portion bearing a short ascending soriferous spur near the base; sori round (or slightly elliptic), about 1.5 mm. in diameter, often confluent, occupying the upper half of the frond, receptacles plane, elliptic, about 1 mm. in length, occupying the entire soriferous spur of the vein; sporangia crowded, subglobose, about 0.17 mm. in diameter, the stalks slender, about 0.3 mm. long.

Slopes and flats at Central Camp, 4800 ft., *553.* A species of the section *Grammitis*, allied to *P. leptopodon* C. H. Wright, endemic to Mt. Roraima, from which it differs by having the rhizome scales narrower, the stipes shorter, the fronds oblong-linear rather than oblanceolate, the veins simple (the soriferous spur being only long enough to accomodate the receptacle) rather than bifurcate, and the soriferous portion not limited to the apical part of the frond. The leaf tissue of the old fronds often decays leaving a peculiar skeleton of the veins and thickened border.

Polypodium pseudo-fraternum A. C. Smith, sp. nov. Rhizomate repente, lignoso, robusto, dense paleaceo; stipitibus paucis, castaneis, glabris, basi dilatatis; frondibus oblongis, pinnatis; pinnis simplicibus, subsessilibus, lanceolatis, basi inequaliter cuneatis, ad costam adnatis, apice subacutis, margine integerrimis; venulis anastomosantibus, unicum seriem costalem areolarum formantibus; soris globosis, areolas occupantibus.

Rhizome lignose, repent, up to 10 cm. in length, stout (5–10 mm. in diameter), giving rise to numerous long slender roots which are densely clothed with pale brown few-celled hairs, densely paleaceous, the scales castaneous, lanceolate from an ovate base, 5–7 mm. long, 1.5–2.5 mm. broad near the base,

the basal half dilated, strongly cordate, overlapping, affixed at a point about 1 mm. from the rounded lower margin, the upper half lanceolate, long-acuminate at the tip, the margins irregularly dentate with apiculate teeth 0.1–0.2 mm. long, each bisected by a rigid cell wall, the cells large (averaging 0.13 mm. in diameter), transparent, with thick rigid dark brown transverse walls, those of the basal part usually pentagonal, those of the upper part elongated; stipes few to a plant, 8–15 cm. long, about 1.8 mm. in diameter, castaneous, glabrous, sharply angled, dilated at the base; fronds oblong, 18–30 cm. long, 10–16 cm. broad, pinnate, the rachis similar to the stipe, the pinnae subopposite or alternate, distant (about 7 per decimeter), 8–12 per side with an erect terminal one, ascending at an angle of about 50°, subcoriaceous, glabrous, lanceolate, 6–10 cm. long, 5–7 mm. broad, the apex subacute, the base unequally cuneate, about 1.5 mm. broad at the attachment, adnate on both sides of the midrib (very slightly so on the lower side, about 0.8 mm. on the upper side), the margin entire, narrowly cartilaginous, slightly reflexed, sometimes shallowly crenate, the upper pinnae somewhat more adnate, the uppermost pair sometimes joined with the base of the terminal one which may be auriculate on one side; venation pinnate, the midrib prominent on both sides, the veins somewhat obscure, spreading, about 4 per centimeter, anastomosing to form a single costal series of subhexagonal soriferous areoles with a free included veinlet, the outer veinlets free, forking once or twice, ending within the margin; sori occupying the costal areoles, terminal on the included veinlet, distinct, round, about 2 mm. in diameter, the receptacle somewhat sunken, about 0.4 mm. in diameter; sporangia numerous, subglobose, about 0.3 mm. in diameter, the stalks slender, up to 0.4 mm. long.

Summit of Peak 7, 7100 ft., *644*, *645* (type). It is a species of the section *Goniophlebium* Blume, apparently nearest to *P. chacapoyense* Hook., a species of Peru and Bolivia, from which it differs in the shape of its pinnae and its lack of pubescence. The rigid cell-wall skeleton of the rhizome scales of *P. pseudo-fraternum* is a striking feature, found also in *P. chacapoyense*. The cell tissue often decays, leaving the skeleton quite intact. The present species bears a superficial resemblance to *P. fraternum* Schl. & Cham. of the section *Eupolypodium* Diels, from which it differs in details of external structure as well as in venation.

POLYPODIUM ANGUSTIFOLIUM Sw. Agüita, 3100 ft., *938*. Common in tropical America.

Cochlidium attenuatum A. C. Smith, sp. nov. Rhizomate erecto, dense paleaceo; stipitibus caespitosis, subteretibus, brevibus; frondibus simplicibus, coriaceis, linearibus, basi attenuatis, apice subacutis, margine plano; venis immersis, alternis, partium sterilium simplicibus, partium fertilium furcatis; coenosoris oblongis, venarum furcas superiores occupantibus.

Rhizome erect, slender (about 1 mm. in diameter), densely paleaceous, the scales hidden among the leaf bases, pale brown, lanceolate-acuminate from an

oblong base, 2–3 mm. long, about 0.5 mm. broad at the base, the tip short-pilose, the cells in 10–18 longitudinal series with delicate walls; fronds densely caespitose, the stipes subarticulate to the rhizome, subterete, less than 4 mm. in length, the lamina thick coriaceous, glabrous when young, becoming pubescent with minute black hairs (parasites?), linear, 8–12 cm. long, 1–1.5 mm. broad, narrowly attenuate at the base, subacute or rounded at the apex, rarely forked near the apex; venation obscure, the costa thickened, the veins immersed, alternate, of the sterile portion few, simple, ascending, about 2.5 mm. long, of the fertile portion distant (about 6 per centimeter), forked from or near the base, ascending, the upper branch parallel to the costa, about 3 mm. long, sometimes again forked at its tip, the lower branch slightly shorter and somewhat spreading; coenosori oblong, superficial, occupying the upper half of the frond, lying close to the costa on the upper branches of veins, 1.5–2 mm. long, usually not confluent; sporangia crowded, globose, about 0.2 mm. in diameter, cells of the annulus with heavy reddish-brown walls, stalks slender, short, about 0.2 mm. in length.

Slopes of Ridge 25, 5500–6000 ft., *428*. In general appearance the present species resembles *C. furcatum* (Hook. & Grev.) C. Chr. and *C. Connellii* (Baker) A. C. Smith, both of which have simple veins with receptacles nearly or quite terminal. In common with them, *C. attenuatum* has superficial polypodioid sori. Among the species with forked veins, *C. attenuatum* is closest to *C. paucinervatum* (Fée) C. Chr., from which it differs by having the veins forked from the base and the sporangia consequently occupying the upper vein only, while in *C. paucinervatum* the veins are forked near the center of the sporangia-bearing portion.[1] More superficially, the sori of *C. attenuatum* are not consistently confluent, as in *C. paucinervatum*, and the upper fertile portion is never conduplicate.

It is probable that some of the specimens cited by Christensen[2] as *C. furcatum* belong with the present species. Of those I have had opportunity to examine, through the courtesy of Dr. Maxon, *im Thurn 166* and *365*, from Mt. Roraima, show the same type of venation as *C. attenuatum*, while the following specimens show the simple venation which is typical of *C. furcatum:* Trinidad, *Hombersley 277;* British Guiana, Herb. Jenman without number (U. S. Nat. Herb. no. 833006); Brazil, *Spruce 2452, Glaziou 12368*.

Elaphoglossum latifolium (Sw.) J. Sm. South bank of the Caño Negro, Savanna Hills, 4400 ft., *854*. A species of wide American distribution, which future study will probably prove to be an aggregate.

The following specimens were not referred: *381*, sterile (deformed), possibly *Lindsaya; 888*, sterile, *Polypodium? Blechnum?*

[1] See illustration by Goebel in Flora **117**: 118; fig. 10, 11. 1924.

[2] Dansk Bot. Ark. 6^3: 20. 1929.

GLEICHENIACEAE[1]

Species of Mount Duida

DICRANOPTERIS FLEXUOSA (Schrad.) Underw. Dry slopes of Savanna Hills, 4400 ft., *744;* Ridge 15, 6600 ft., *599.* Distributed throughout tropical America. No. *744* is very typical; *599* is more fragmentary, but doubtless belongs here also.

SCHIZAEACEAE[1]

Lowland species

ACTINOSTACHYS PENNULA (Sw.) Hook. Tree Savannas, Esmeralda, *326.* Common throughout eastern South America.

ANEMIA BUNIIFOLIA (Gardn.) Moore. Under rocks, slopes of Esmeralda Ridge, *231.* A rarely collected plant, probably distributed throughout the lowlands drained by northern tributaries of the Amazon.

Species of Mount Duida

LOPHIDIUM ELEGANS (Vahl) Presl. Woods, Laterite Valley, Savanna Hills, 4400 ft., *725.* A very variable species throughout the American tropics.

LYCOPODIACEAE[1]

Lowland species

LYCOPODIUM CERNUUM L. New Savanna, Esmeralda, *358;* the common tropical species.

LYCOPODIUM (sterile). East swamp, Esmeralda, *249,* probably sect. *Selago;* East Swamp, Esmeralda, *254,* sect. *Selago,* a species close to *L. portoricense* Underw. & Lloyd.

SELAGINELLA FLABELLATA (L.) Spring. Woods at Foothills Camp, 750 ft., *376.* Distribution, tropical America.

SELAGINELLA RADIATA (Aubl.) Baker. Manáos, *47;* rocky top of Esmeralda Ridge, *201;* tree savannas, Esmeralda, *327;* a species of tropical America from Costa Rica and Guiana to Peru. The present specimens have regular and rather elongate branches.

SELAGINELLA PARKERI (Hook. & Grev.) Spring. Woods at Foothills Camp, 750 ft., *1007.* A species of Guiana and the Amazon basin.

SELAGINELLA CALCARATA A. Br. River banks and flood sands, Muyrapenima, Rio Negro, Brazil, *56.* Distribution, in lowlands on the northern part of the continent; apparently rare.

Species of Mount Duida

LYCOPODIUM CERNUUM L. Crest of Ridge 25, 6300 ft., *407;* the common tropical species.

[1] By Albert C. Smith.

Lycopodium iuliforme Underw. & Lloyd. Slopes of Ridge 25, 5500–6000 ft., *406;* previously known only from Mt. Roraima. Although the description of this species[1] says "sporophylls 8-ranked," one strobilus of the type specimen shows them 4-ranked, while a strobilus of *Tate 380* from the type locality shows them 6-ranked. The present specimen has sporophylls both 4- and 6-ranked.

Lycopodium duidae A. C. Smith, sp. nov. Caule procumbente, folioso; foliis lanceolato-acuminatis, integerrimis, ipsis facierum inferiorum adpressis, membranaceis, ipsis facierum superiorum extensis, subcoriaceis; ramis adscendenti-erectis, cylindraceis,foliosis, foliis adpressis, lanceolato-linearibus, acuminatis; strobilis apice ramulorum terminalibus, solitariis; sporophyllis lanceolatis, basi rotundatis, apice longe acuminatis, margine irregulariter ciliatis; sporangiis reniformibus, in axillis sporophyllorum sitis.

Plant terrestrial, stem creeping, with upright monostachyous branches; creeping stems cylindric, about 2 mm. in diameter; leaves 8–12-ranked, lanceolate-acuminate, 4–6 mm. long, about 0.7 mm. across the base, midrib obscure, margin entire, those of the lower surface appressed, colorless, membranaceous, those of the lateral and upper surfaces spreading, somewhat secund, subcoriaceous; erect branches cylindric, about 14 cm. high (exclusive of strobili), about 1.3 mm. in diameter, uniformly leafy with 6-ranked appressed linear-lanceolate long-acuminate subcoriaceous leaves 6–7 mm. long, about 0.8 mm. across the base, the margins entire and incurved, often touching; strobili about 4.5 cm. long, 1.5 cm. in diameter (including the wide-spreading sporophylls); sporophylls lanceolate, 8-ranked, about 7 mm. long, 2 mm. broad near the base, tapering to a long-acuminate apex, subcoriaceous at the center, membranaceous at the irregularly ciliate margins, the base rounded to a membranaceous attachment 1 mm. long and 1 mm. broad; sporangia reniform, about 1.2 mm. broad, attached near the base of the inner surface of the sporophyll.

Central Camp, 4800 ft., *1010*. It is a species allied to *L. iuliforme* Underw. & Lloyd and *L. Tatei* A. C. Smith, both found on Mt. Roraima and the former on Mt. Duida as well. The present species has sporophylls less crowded, more noticeably ciliate, longer, and more lanceolate than *L. iuliforme.* It is distinguished from *L. Tatei* by having cylindric rather than flattened creeping stems, longer erect branches, and sporophylls which are larger particularly as regards the basal attachment. *L. iuliforme* has more regular and compact appearing strobili than either of its allies.

Selaginella Tyleri A. C. Smith, sp. nov. Caulibus ubique radicantibus; ramis simplicibus vel ramosis; foliis facierum inferiorum subimbricatis, ovatis, utrinque pilosis, inaequilateralibus, apice acutis, basi cuneatis, margine membranaceis et ciliatis; foliis facierum superiorum similibus, minoribus; spicis apice ramulorum terminalibus; sporophyllis imbricatis, ovatis, utrinque parce

[1] Bull. Torr. Club 33: 120. 1906.

pilosis, apice breve acuminatis, margine ciliatis; sporangiis in axillis sporophyllorum sitis.

Plants suberect, up to 15 cm. high, forming a mat; rhizophores several from the base of the shoots; stem (including leaves) 3–4 mm. broad (exclusive of leaves 0.5–0.8 mm. in diameter), branched at intervals of 3 to 6 mm., branches many, those towards the base short and simple, those towards the apex branched once or twice more; leaves of the lower plane spreading, close, sometimes slightly imbricate, yellowish green, firm, ovate, about 1.8 mm. long and 0.8 mm. broad, ventriculose near the base of the upper edge, acute at the apex, cuneate at the base to a short ligulate attachment about 0.2 mm. broad, the margins narrowly membranaceous, entire, fringed with about 50 persistent unicellular colorless hairs 0.12–0.3 mm. in length, longest on the upper margin near its base, midvein broad, plane on the ventral surface, slightly raised on the dorsal, both surfaces with scattered hairs similar to those of the margins, those of the dorsal surface longer and fewer than those of the ventral surface; leaves of the upper plane the same shape and texture, about 1.1 mm. long and 0.6 mm. broad, ventriculose near the base of the lower edge, short acuminate at the apex, the cilia not exceeding 0.26 mm. in length; spikes short (not exceeding 5 mm. in length), square, about 2.5 mm. in diameter (including the sporophylls), not sharply differentiated from the sterile portion; sporophylls imbricate, resembling the sterile leaves, ovate, about 1.3 mm. long and 0.8 mm. broad, short-acuminate at the apex, narrowed at the base to 0.15 mm., the marginal cilia abundant, about 0.2 mm. long, very sparsely pubescent on the surfaces, the ventral surface strongly concave; sporangia large, with a membranous and nearly colorless envelope, attached near the base of the sporophyll; megasporangia tetrahedral, about 0.7 mm. average diameter, megaspores 4, pale yellow, about 0.4 mm. in diameter, rugose; microsporangia ovoid, about 0.5 mm. by 0.65 mm., microspores abundant, pale orange, about 0.035 mm. in diameter.

Slopes of Ridge 24, beneath rock, 5600 ft., *463*. A species belonging to the group of *S. atroviridis* Spring, allied to *S. Martensii* Spring, *S. vernicosa* Baker, etc., but easily recognized by its striking and persistent pubescence.

Selaginella duidae A. C. Smith, sp. nov. Caulibus basi reclinatis, supra adscendentibus, parce radicantibus; foliis facierum inferiorum extensis, glabris, ovatis, inaequilateralibus, apice subacutis, basi rotundatis et sessilibus, margine superiore serratis, margine inferiore integerrimis; foliis facierum superiorum similibus, minoribus, apice acuminatis, margine toto serratis; spicis apice ramulorum terminalibus, sporophyllis imbricatis, triangulari-ovatis, sulcatis, glabris, apice acuminatis, margine serratis; sporangiis in axillis sporophyllorum sitis.

Stems decumbent at the base, then ascending, up to 15 cm. high; rhizophores several from the base of the shoots, 0.2 mm. in diameter; stem (includ-

ing leaves) 3.5–4 mm. broad (exclusive of leaves 0.4–0.7 mm. in diameter), sparsely branched; leaves of the lower plane spreading, spaced (6 to 8 per centimeter), dull green, firm, glabrous, ovate, 1.3–2 mm. long, 0.65–0.9 mm. broad, ventricose on the upper edge, subacute at the apex, rounded to the sessile base, the upper margin serrate with about 15 cartilaginous apiculate teeth (not exceeding 0.05 mm. in length), the lower margin entire, both surfaces plane, the ventral somewhat concave; leaves of the upper plane hardly imbricate, of the same texture as the larger leaves, ovate, 0.9–1.3 mm. long, 0.4–0.65 mm. broad, ventriculose at the base of the lower edge, acuminate at the apex, rounded at the sessile base, the margins serrate with minute cartilaginous apiculate teeth (about 10 to a side, not more than 0.03 mm. long); spikes 4–6 mm. long, square, about 3 mm. in diameter (including the sporophylls); sporophylls imbricate, of the same texture as the sterile leaves, triangular-ovate, strongly sulcate, about 1.4 mm. long and 0.75 mm. broad, acuminate at the apex, rounded at the base, the margins serrate with minute apiculate teeth (about 20 to a side, not more than 0.03 mm. long), the ventral surface strongly concave, bearing the sporangia at its base; sporangia with a colorless membranous envelope; megasporangia tetrahedral, about 0.6 mm. in diameter, megaspores pale yellow, rugose, about 0.3 mm. in diameter; microsporangia ovoid, about 0.6 mm. by 0.4 mm., microspores abundant, yellow, about 0.03 mm. in diameter.

Laterite Valley, Savanna Hills, 4400 ft., *839*. It is a species with few branches and spreading, rather distant, leaves which are serrate only on the upper margin, in habit resembling *S. vernicosa* Baker.

Selaginella microdonta A. C. Smith, sp. nov. Caulibus laxis, reclinatis, parce radicantibus; foliis facierum inferiorum extensis, orbiculari-ovatis, glabris, apice subacutis, basi rotundatis et sessilibus, margine callosis et minute serratis; foliis facierum superiorum ovatis, glabris, apice acutis, basi rotundatis vel cordulatis, sessilibus, margine minute serratis; spicis apice ramulorum terminalibus; sporophyllis imbricatis, triangulari-ovatis, sulcatis, glabris, apice acutis, basi rotundatis, margine minute serratis; sporangiis in axillis sporophyllorum sitis.

Stems lax, decumbent, up to 14 cm. long; rhizophores several towards base of stems, 0.1 mm. in diameter; stem (including the leaves) 3.5–4 mm. broad (exclusive of leaves 0.2–0.3 mm. in diameter), sparsely branched; leaves of the lower plane spreading, about 7 per centimeter, membranaceous, glabrous, orbicular-ovate, 1.8 mm. long, 1.6 mm. broad, subacute at apex, rounded to the sessile base, margins thickened, slightly revolute, faintly serrate to base (teeth apiculate, about 30 per side), surfaces plane; leaves of the upper plane not imbricate, of the same texture as the larger leaves, ovate, 0.8 mm. long, 0.5 mm. broad, subventricose at base of the lower edge, acute at apex, rounded or cordulate at the sessile base, margins faintly serrate (teeth minute, about

15 per side); spikes 4–7 mm. long, about 2.5 mm. in diameter (including the sporophylls); sporophylls imbricate, of the same texture as the sterile leaves, triangular-ovate, sulcate, about 1.5 mm. long and 0.8 mm. broad, acute at apex, rounded at base, margins faintly serrate (teeth minute, about 25 per side), the ventral surface strongly concave, bearing the sporangia at its base; sporangia with a colorless membranous envelope; megasporangia tetrahedral, about 0.5 mm. in diameter, megaspores pale yellow, 0.25 mm. in diameter; microsporangia ovoid, about 0.6 mm. by 0.4 mm., microspores abundant, minute.

In creek bed, Provisional Camp, slope of Ridge 24, 6000 ft., *509*. It is a species allied to the preceding, but with the leaves more broadly ovate, thick-margined, more membranous in texture, serrate on both margins, and smaller (especially those of the upper plane).

SELAGINELLA RADIATA (Aubl.) Baker. At Agüita, 3100 ft., *890*. A species of tropical America from Costa Rica and Guiana to Peru.

Selaginella scalariformis A. C. Smith, sp. nov. Caulibus basi reclinatis, supra rigide suberectis, parce radicantibus; foliis facierum inferiorum extensis, horizontalibus, coriaceis, glabris, olivaceis, ovatis, inaequilateralibus, apice acutis, basi rotundatis et sessilibus, margine irregulariter minute serratis; foliis facierum superiorum similibus, apice breviter acuminatis; spicis regularibus, robustis; sporophyllis imbricatis, triangulari-ovatis, apice acutis, basi truncatis, margine serratis; sporangiis in axillis sporophyllorum sitis.

Plants stiffly suberect, 4–7 cm. high, growing on dry rocks; rhizophores many from the base of the shoots, stout (about 0.25 mm. in diameter); stem (including leaves) 1.3–2.5 mm. broad (exclusive of leaves 0.4–0.5 mm. in diameter), simple or with a few short branches; leaves of the lower plane spreading, close, horizontal, stiff-coriaceous, concave, olive green, glabrous, ovate, about 1.3 mm. long and 0.75 mm. broad, ventriculose near the base of the upper edge, acute at the apex, rounded to the sessile base, the margins narrowly membranaceous and irregularly serrate with minute apiculate teeth (less than 0.04 mm. in length); leaves of the upper plane the same shape and texture, imbricate, about 0.9 mm. long and 0.5 mm. broad, ventriculose near the base of the lower edge, short-acuminate at the apex, irregularly serrate with membranous teeth (up to 0.06 mm. long, sometimes slightly piliform); spikes regular, up to 6 mm. in length (rarely to 10 mm.), square, somewhat stouter than the contracted sterile branch immediately beneath, about 2 mm. in diameter (including the sporophylls); sporophylls crowded, imbricate, triangular-ovate, about 1.5 mm. long and 0.9 mm. broad, strongly concave, acute at the apex, truncate at the base to a short ligulate attachment about 0.18 mm. broad, the margins regularly serrate with membranaceous triangular apiculate teeth about 0.05 mm. long; sporangia large, with a yellowish membranous envelope, attached at the base of the sporophyll; megasporangia

tetrahedral, about 0.6 mm. in diameter, megaspores not observed; microsporangia ovoid, about 0.6 mm. by 0.5 mm., microspores abundant, yellow, about 0.04 mm. in diameter.

Gorge of the Caño Negro, Savanna Hills, 4000 ft., *817;* a stiff, few-branched plant, marked by its horizontal sessile leaves and comparatively large sporophylls. Probably it is best placed in the group of *S. radiata.*

PODOCARPACEAE

Species of Mount Duida

PODOCARPUS RORAIMAE Pilger. Summit of Peak 7, 7100 feet, *659.* The species has been known hitherto only through its original collection by Ule at similar altitudes on Mount Roraima.

GRAMINEAE[1]

Lowland species

ERAGROSTIS BAHIENSIS Schrad. Yucabí, on the Rio Negro, northern Brazil, *974;* grassy hills and plains, Brazil to Bolivia and Argentina.

ARISTIDA TORTA (Nees) Kunth. Grassy savannas bordering sandstone ridges, Esmeralda, *172;* open or brushy slopes or campos, British and French Guiana, Venezuela, and Brazil.

LEPTOCORYPHIUM LANATUM (HBK.) Nees. Grassy savannas bordering sandstone ridges. Esmeralda, *174;* pine barrens and open or brushy savannas, Mexico and the West Indies to Argentina.

OLYRA LATIFOLIA L. Middle Camp, Esmeralda, *344;* woodlands, Mexico and the West Indies to Bolivia and Brazil.

RADDIA NANA (Döll) Chase. Rocky top of Esmeralda Ridge, *1004;* moist banks, Trinidad, British Guiana, Venezuela, and Brazil.

ANDROPOGON SELLOANUS (Hack.) Hack. Grassy savannas bordering sandstone ridges, Esmeralda, *173;* open savannas, West Indies to Bolivia and Argentina.

Species of Mount Duida

CHUSQUEA WEBERBAUERI Pilger. Summit of Peak 7, 7100 ft., *651;* mountain meadows and paramos, Venezuela, Colombia, and Peru.

Three sterile specimens of bamboos from the summit of the mountain, *678, 687,* and *714,* could not be satisfactorily identified.

ECHINOLAENA INFLEXA (Poir.) Chase. Dry ridge tops, Savanna Hills, 4400 ft., *804;* brushy slopes and savannas, British and French Guiana, Venezuela, Colombia, and Brazil.

[1] By Jason R. Swallen.

PASPALUM CONTRACTUM Pilger. Dry slopes of Savanna Hills, 4400 ft., *742;* open stony slopes and savannas, Panama to Colombia and Brazil.

PANICUM OBOVATUM Döll. Gorge of Caño Negro, Savanna Hills, 4000 ft., *812;* Venezuela and Brazil (Rio Negro).

Panicum curvifolium Swallen, sp. nov. Perenne; culmi erecti robusti 105–130 cm. alti; folia fere basi aggregata, curvata; vaginae dense pilosae, laminae planae, rigidae, erectae, pungentes, basi dense pilosae, apice glabrae vel scabrae, 40–50 cm. longae, 5–12 mm. latae; ligula obsoleta; panicula 10–12 cm. longa, 12 cm. lata, ramis adscendentibus vel latis expansis; spiculae 2.2 mm. longae, glabrae; gluma prima acuta 1.5 mm. longa; palea sterilis lemmati sterile aequilonga.

Perennial, culms stout, erect, 105–130 cm. tall; leaves mostly crowded toward the base, the upper ones of the basal cluster stiffly erect, the lower ones becoming brown and much curled with age, culm leaves one or two, distant, reduced; sheaths loose, very densely pilose with stiff hairs except those of the culm, these pilose below or nearly glabrous; blades 40–50 cm. long, 5–12 mm. wide, thick and firm, narrowed toward the base, the juncture with the sheath inconspicuous, more or less involute toward the pungently pointed tip, densely pilose on both surfaces toward the base, becoming glabrous or scabrous toward the tip, the margins scabrous; ligules obsolete; panicles pyramidal, 10–12 cm. long, 12 cm. wide, the branches stiffly ascending to widely spreading; spikelets 2.2 mm. long, glabrous; first glume acute, about half the length of the spikelet; second glume and sterile lemma equal, the latter enclosing a well developed palea as long as the sterile lemma; fruit 2 mm. long, pointed, golden yellow, smooth and shining.

Moist slopes of Savanna Hills, 4400 ft., *776.* The species is allied to *Panicum chnoodes* Trin., but differs in the coarser aspect, the smaller spikelets, and the obsolete ligule.

Panicum Tatei Swallen, sp. nov. Perenne; culmi erecti vel adscendentes, 30–50 cm. alti; laminae laeves, rigidulae, pungentes, subinvolutae, 10–20 cm. longae, 2–4 mm. latae; ligula obsoleta; panicula densa 6–10 cm. longa, 2–4 cm. lata, ramis anguste adscendentibus; spiculae 2.2 mm. longae; gluma prima 1.5 mm. longa, acuta, 1–3-nervia; palea sterilis lemmati sterili aequilonga.

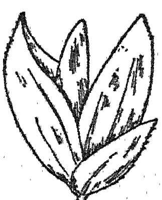


Fig. 2. *Panicum Tatei*, spikelet ×10.

Perennial; culms erect or ascending, 30–50 cm. tall; leaves crowded toward the base, smooth throughout; sheaths loose, sometimes sparsely ciliate on the margins; blades firm, folded, pungently pointed, 10–20 cm. long, 4–6 mm. wide; ligule obsolete, the juncture of the sheath and blade obscure; panicles rather dense, 6–10 cm. long, 2–4 cm. wide, more or less enclosed in the upper leaves, the branches narrowly ascending, spikelet-bearing from above the middle; spikelets 2.2 mm. long; glumes and sterile lemma acute, scabrous on the keels; first glume 1–3-nerved, somewhat clasp-

ing, 1.5 mm. long; second glume and sterile lemma equal, 5-nerved, diverging at maturity, exposing the fruit; sterile palea well developed, as long as the sterile lemma; fruit 2 mm. long, yellowish, smooth and shining (Fig. 2).

Near summit of Ridge 25, 6000 ft., *524*, *1030* (type). This species is allied to *Panicum loreum* Trin., but differs in being glabrous and in the absence of a ligule. In occasional spikelets there are two sterile lemmas, the lower one of which is without a palea.

RADDIA NANA (Döll) Chase. Rocks above Caño Negro, Savanna Hills, 4200 ft., *820;* moist banks, Trinidad, British Guiana, Venezuela, and Brazil.

CYPERACEAE[1]

Lowland species

CYPERUS HASPAN L. East swamp at Esmeralda, *247;* widely distributed in the American tropics from the southern United States to Brazil.

DICHROMENA CILIATA Vahl. Santa Isabel on the Rio Negro, *104;* West Indies and Mexico to Brazil and Bolivia.

DIPLAZIA KARATAEFOLIA L. C. Rich. S˜o Sebastian on the Rio Casiquiare, *156;* a striking species of the Amazonian forests, ranging from Trinidad to Bolivia.

ELEOCHARIS sp. East Swamp at Esmeralda, a juvenile plant, *258*.

LAGENOCARPUS (?) RIGIDUS Nees. East swamp at Esmeralda, *238;* also known from central Brazil.

LAGENOCARPUS (?) sp. Rocky top of Esmeralda Ridge, *191*.

PSILOCARYA CANDIDA Nees. East Swamp at Esmeralda, *256;* also known from British Guiana.

PSILOCARYA sp. Grand Savanna at Esmeralda, *296*.

RYNCHOSPORA BARBATA (Vahl) Kunth. East Swamp and grassy meadows at Esmeralda, *171*, *260;* widely distributed in tropical America from Hayti to Colombia and northern Brazil.

RYNCHOSPORA CEPHALOTES (L.) Vahl. Muyrapenima on the Rio Negro, *64;* Cuba and Central America to Brazil.

RYNCHOSPORA GLOBOSA (HBK.) R. & S. Dry savannas at Esmeralda, *278;* Mexico and Cuba to Brazil and Bolivia.

RYNCHOSPORA sp. East Swamp at Esmeralda, *240*, *243*.

STENOPHYLLUS JUNCIFORMIS (HBK.) Britt. Grassy meadows at Esmeralda, *170;* rocky top of Esmeralda Ridge, *204*. The species ranges from Cuba and Mexico to Bolivia and Brazil.

[1] By N. L. Britton.

Stenophyllus lanatus (HBK.) Britt. nov. comb. *Isolepis lanata* HBK. Nov. Gen. & Sp. **1**: 220. pl. 68. 1816.

Savannas and rocky places at Esmeralda, *185, 205, 279, 951;* also known from the Guianas.

Species of Mount Duida

EVERHARDIA (?) MONTANA Ridley. Summit of peak 7, 7100 ft., *638.* The type and only other known station is Mount Roraima.

EVERHARDIA spp. Other material of this genus, apparently endemic to the mountains from Duida to Roraima, may represent three or even four undescribed species, but is not in good condition and is consequently left undescribed. Here are included numbers *469, 542, 720, 721, 800,* and *816,* from altitudes between 4000 and 6800 feet.

LAGENOCARPUS (?) RIGIDUS Nees. Ridge northwest of Vegas Brook, *570.*

LAGENOCARPUS sp. Savanna Hills, 4400 ft., *1040.*

RYNCHOSPORA sp. Savanna Hills, 4400 ft., *746.*

SCLERIA CYPERINA Kunth. Savanna Hills, 4500 ft., *738;* Venezuela and Bolivia.

STENOPHYLLUS sp. Savanna Hills, 4400 ft., *799.*

PALMAE[1]

Lowland species

GEONOMA BACULIFERA (Poit.) Kunth. Left bank of the Rio Casiquiare at Quemapure, *166;* bekannt von Guayana bis Pará.

Geonoma chaunostachys Burret, sp. nov. Palma acaulis, 3 m. alta. Petiolus ad apicem supra 0.5 cm. latus, plus minus fusco-leprosus, glabrescens. Rachis 60 cm. longa, subtus fusco-leprosa. Lamina inter firmiores, i. s. utrinque fere concolor, nervis primariis utrinsecus 22, basi sat anguste nonnihil cuneatim protracta, sed non in petiolum decurrens, frondis unius visae 90 cm. circ. longa, in altero latere indivisa, in altero segmentis 3. Segmenta 4–7 cm. dissita, 4–6, 5 cm. lata, porrecta, vix falcata, apice anguste acuminata, praeter apicalia subito contracta, apicalia 30 cm. fere longa. Nervi primarii subtus valde prominentes, ardui, in dimidia lamina angulo 30° rachin petentes, versus quam paulo curvati, inferiores angulo etiam acutiore ascendentes. Nervi secundarii subtus ejusdem circ. valitudinis, primo visu vix distinguendi, sed paulo latiores. Inter primarium et secundarium tertiarii nonnulli, utrinque, subtus melius conspicui. Spadix simplex, ut videtur, longe pedunculatus. Pedunculi fragmentum visum 29 cm. longum, inferne applanatum. Spica fructifera apice destructa circ. 11 cm. longa. Axis inter tenuiores, in internodis 4 mm. in diam., i. s. atrofusca, granulosa. Foveae laxe, in dimidia spica fere regu-

[1] By M. Burret.

lariter ad 3 in verticillis alternantibus, in orthostichis 6 dispositae, ejusdem orthostichae sequentes 7 mm. inter partes aequales dissitae, bilabiatae. Labium superius ab axi conspicue protractum, inferius incisum. Fructus i. s. nigri, ovales, 9×7 mm., densissime, minutissime granulosi. Pericarpium 0.75 mm. in diam. Semen 6–5.5×5 mm.

Slopes of Mount Duida, 750 ft., *394*. Die Art schliesst sich am besten an *G. Brongniartii* Mart. an, unterscheidet sich jedoch durch die kräftigere Kolbenähre, die bedeutend grösseren Früchte, die steileren Nerven, und die ziemlich lang keilförmige Blattbasis.

GEONOMA HEXASTICHA Spruce. Forest at Middle Camp, Esmeralda, *355*. Von der genannten Art, die von Spruce am oberen Rio Negro gesammelt wurde, liegt mir zur Zeit nur eine Photographie vor. Zu vergleichen ist hiermit auch *G. maxima* (Poit.) Kunth, die mir nicht ausreichend bekannt ist.

The following specimens are sterile: *Geonoma* sp. Forest at Middle Camp, Esmeralda, *350; Bactris* sp. Buena Vista on the Rio Casiquiare, *157; Catoblastus* sp. Forest at Middle Camp, Esmeralda, *349; Lepidocaryum* sp. Acaulescent, a foot high, Esmeralda, *242; Maximiliana* sp. Forest at Middle Camp, Esmeralda, *356*.

Species of Mount Duida

Euterpe montis-Duida Burret, sp. nov. Palma 20 pedes alta. Caudex tenuis, 3 cm. circ. in diam. metiens, annulis densis, 1 cm. vix dissitis. Frondis rachis plus minus glabrata, parce atro-leprosa. Segmenta, ut videtur, subhorizontaliter patentia, rachi oblique spatiis regularibus in eadem planitie inserta, frondis fragmenti parvi visa 50 cm. fere longa, anguste nonnihil acuminata, a dimidio inferne conspicue angustata, nervis majoribus praeter marginales dextra sinistra 2, tenuibus subtus conspicuis plurimis percursa, subtus trichomatibus minutissimis, brunneis sub lente forti densiuscule punctata. Spadix parvus. Pedunculus 9 cm. circ. longus, i. s. apice 1 cm. in diam. Spathae superioris annulus 2.5 cm. a ramo infimo dissitus, tertia incompleta interposita oblongo-lanceolata, 5.5 cm. longa, 1 cm. lata, tenuis, intus glabra, extus fere glabrata, fusco-leprosa; supra hanc bracteam ulterior sterilis elongato-triangularis, 1 cm. longa. Rami infimi bracteis triangularibus, pro rata nonnihil evolutis, bracteae superiores diminuentes. Rachis 21 cm. longa, ut rami indumento brevi i. s. sordide brunneo-flavo densissime obtecta, pilis oculo inermi inconspicuis, tactu haud sensibilibus. Rami numerosi, inter minus validos, majores circ. 40 cm. longi, ad florum glomerulos subflexuosi, longitudinaliter angulosi. Glomeruli usque ad dimidium ramum floribus 3, masculis 2 femineo superpositis, supra plerumque floribus 2. Flores masculi non visi, feminei ovati glabri.

Slopes of Ridge 25, 5500–6000 ft., *452*. Leider liegt die Art in einem ungünstigen Stadium vor, indem weder Früchte noch männliche Blüten

vorhanden sind. Von den bisher bekannten Arten kommt nur *E. longibracteata* Barb. Rodr. in Betracht, an die sie nach deren Abbildung und Beschreibung am besten anzuschliessen ist. Die Brakteen sind hier weniger stark entwickelt. Bei *E. longibracteata* ist die Behaarung des Kolbens in trockenen Zustand wahrscheinlich weiss, bei *E. montis-Duida* bräunlich gelb. Nach Beschreibung und Abbildung ist bei *E. longibracteata* immer nur eine männliche Blüte über der weiblichen inseriert, während hier wenigstens bis zur Mitte der Äste regelmässig Blütentriaden vorhanden sind. In der Anordnung und Beschaffenheit der Fiedern vermag ich keinerlei Unterschiede festzustellen. Jedoch ist nach den vorhandenen Stammstücken dieser bei *E. montis-Duida* ganz bedeutend dünner.

Bei dieser Gelegenheit möchte ich bemerken, dass ich in Engl. Bot. Jahrb. **53:** 52 den Stamm von *E. longibracteata* durch ein Versehen mit 7–8 m. anstatt 4–5 m. angegeben habe.

GEONOMA sp. Near summit of Peak 7, 7050 ft., *679*, growing ten feet high, sterile.

CYCLANTHACEAE

Lowland species

CARLUDOVICA sp. A sterile plant, described as an epiphyte 30 feet long, was collected at Foothills Camp, lower slopes of Mount Duida, *382*.

Species of Mount Duida

CARLUDOVICA sp. Leaves of a small plant three feet high were collected at Central Camp, 4800 ft., *573*, and fruiting peduncles of another at Desfiladero, 6000 ft., *697*.

CYCLANTHUS BIPARTITUS Poit. Growing ten feet high at Agüita, 4000 ft., *907*. The species occurs from the West Indies to Peru.

ARACEAE

Lowland species

ANTHURIUM HOOKERI Kunth. Rocky top of Esmeralda Ridge, *189*. The species has been known from the Lesser Antilles to the Guianas: the present record is a considerable extension of its range.

SPATHIPHYLLUM CANNIFOLIUM (Dryand.) Schott. In stream gravel, woods at Foothills Camp, base of Mount Duida, 750 ft., *390;* common throughout northern South America.

Species of Mount Duida[1]

ANTHURIUM QUINQUENERVIUM Kunth. Slopes of Ridge 25, 5100 ft., *474;* terrestrial, 4 ft. high, erect, bracts yellow-green. The only previous collection is that of Humboldt in the Andes of Pasto.

[1] By K. Krause.

ANTHURIUM RORAIMENSE N. E. Br. South Bank of the Caño Negro, Savanna Hills, 4400 ft., *855;* also on Mount Roraima. The plant was collected without flowers, but I think it belongs to this species.

PHILODENDRON MACROGLOSSUM Schott. On rocks, Savanna Hills, 4400 ft., *831;* known only from Venezuela.

Philodendron Tatei Krause, sp. nov. Planta terrestris. Foliorum petiolus ignotus; lamina magna rigida crasse coriacea elliptica apice breviter acuminata basin versus subrotundatus ima basi paullum decurrens, 4.3 dm. longa, fere 3 dm. lata, nervis lateralibus primariis 12–14 supra impressis subtus distincte prominentibus angulo circ. 60–70° costa valida subtus praesertim basin versus valde prominente abeuntibus prope marginem arcuatim adscendentibus venis secundariis tenuioribus primariis parallelis percursa. Pedunculus teres validus, circ. 5 cm. longus, siccus 5 mm. crassus. Spathae carnosae in siccitate obscure brunneae tubus late ovoideus 5 cm. longus, 4–5 cm. latus, lamina anguste lanceolata, apice breviter acuminata, 10–12 cm. longa, inferne expansa 3–4 cm. lata sursum attenuata. Spadicis brevissime stipitati in siccitate brunnei inflorescentia feminea in statu maturescente oblongo-ellipsoidea, circ. 4.5 cm. longa, fere 3 cm. crassa, pars sterilis brevis vix contracta, inflorescentia mascula anguste conoidea apice acuta, circ. 10 cm. longa, inferne 1–1.2 cm. crassa, sursum sensim attenuata. Pistilla oblonga, vertice truncata, stigmate vix elevato coronata, 5–6 mm. longa, 2 mm. lata; ovula numerosa. Flores masculi plerumque 4–5-andri; stamina prismatica vertice truncata, 3–4 mm. longa.

Savanna Hills, 4400 ft., *845*. The large, thickly coriaceous leaves are very characteristic for this beautiful species, which resembles *P. longipes* Engl. and *P. graveolens* Engl., both from Colombia.

PHILODENDRON sp. On rocks, Savanna Hills, 4400 ft., *830*. The plant has very characteristic, thickly coriaceous leaves, the basal lobes of which are largely connivent. It is certainly a new species, but without flowers it is too incomplete for description.

STENOSPERMATIUM sp. Three feet tall, spathes white: Agüita Slope, 3500 ft., *702*.

MAYACACEAE

Lowland species

MAYACA FLUVIATILIS Aubl. In the water of East Swamp, Esmeralda, *272*. This is probably the commonest species of the genus, ranging from the southern United States southward throughout tropical America.

MAYACA SELLOWIANA Kunth. In open sandy swamp, Camanaos, on the Rio Negro, northern Brazil, *120;* East Lake at Esmeralda, *251*. Tropical South America.

XYRIDACEAE[1]

Lowland species

XYRIS LONGICEPS Malme. Swampy ground, Grand Savanna, Esmeralda, *301;* also known from Surinam.

XYRIS SAVANNENSIS Miq., Sandy swamp, top of Esmeralda Ridge, *215;* Guiana, Venezuela, and Colombia, south to Rio Grande do Sul, Paraguay, and Bolivia.

XYRIS LACERATA Pohl. Wet or open savanna, Esmeralda, *184, 263;* Colombia, Venezuela, Matto Grosso, and Goyaz.

Xyris subglabrata Malme, sp. nov. Subbulbosa (vel caespitosa), humilior; scapi recti, subteretes, ecostati, subtiliter transversim rugulosi vel superne laevigati; folia rigida, crassiuscula, complanata, scapo paullo usque duplo breviora, subtiliter transversim rugulosa, aciebus obtusissimis, vagina tertiam vel quartam partem folii occupans, indistincte limitata (ligula nulla), eciliata, deorsum sensim, basi valde dilatata, sordide ferruginea, opaca. Spica satis pauciflora, obovoidea; bracteae coriaceae, integerrimae, fulvae vel fulvo-castaneae, intermediae (fertiles) ovales vel obovatae, apice rotundatae, area dorsali magna, cinereo-viridi, carinata ornatae, steriles paucae, ovatae, obtusae, intermediae saltem duplo breviores; sepala lateralia subaequilatera, lanceolata, acuta, ala carinali angusta, in parte tertia media ciliato-scabridula, apicem versus ciliato-villosa.

Scapi 12–18 cm., raro usque 25 cm. alti, circiter 0.7 mm. crassi; folia 10–12 cm., raro usque 15 cm. longa, circiter 1 mm. lata, acuta vel obtusiuscula, vagina circiter 3 cm. longa; spica 5–7 mm. longa, circiter 4 mm. crassa; bracteae infimae 1.5–2 mm. longae, intermediae 5 mm. longae et 3 mm. latae, area dorsali triangulari-ovata, carina saepissime in mucronem brevissimum excurrente; sepala lateralia libera, circiter 4.5 mm. longa, usque 0.8 mm. lata.

Petals crimped, orange-yellow; in swampy ground, Grand Savanna, Esmeralda, *303.* Affinis, etsi vix arctius, *X. glabratae* Griseb., in Guiana et Trinidad occurrenti, foliis recedenti utroque latere laevibus, vagina laevigata, nitida, scapis altioribus, bracteis infimis spicae longioribus (intermediis paullo, raro fere duplo brevioribus), et carina sepalorum lateralium eciliata vel irregulariter serrulata.

XYRIS LOMATOPHYLLA Mart. Swampy ground, Grand Savanna, Esmeralda, *294;* Amazonas ("in campis montis Araracoara"). Specimina a Tate collecta quam typus altiora et robustiora; folia usque 20 cm. longa, 4–5 mm. lata, vagina 4–5 cm. longa; scapi saltem usque 60 cm. alti, 1.5–2 mm. lati; bracteae spicae superne pilis albidis crispulis ciliatae.

XYRIS ERIOPHYLLA Reichenb. Swampy ground, Grand Savanna, Esmeralda, *304;* Guiana et Amazonas (Colares). Specimina a Tate col-

[1] By G. A. Malme.

lecta a guianensibus recedunt foliis longioribus, usque 33 cm. longis, utraque vel altera acie pilis usque 2 mm. longis, albidis, crispulis ciliatis (demum saepe glabratis), et scapis usque 38 cm. altis, altera acie albido-ciliatis.

XYRIS JUPICAI Rich. Esmeralda, specimen unicum cum no. *245* immixtum; a Maryland et Texas ad Paraguay et Uruguay.

ABOLBODA POEPPIGII Kunth. In running stream in woods, Grand Savanna, Esmeralda, *299;* Pará.

ABOLBODA MACROSTACHYA Spruce. Grand Savanna, Esmeralda, *244;* eodem loco jam a Spruce lecta.

Species of Mount Duida

XYRIS TENELLA Kunth, var. SUBTENELLA Malme. Gorge of Caño Negro, Savanna Hills, 4000 ft., *810.* Quam typus humilior, foliis tantum usque 4 cm. longis, raro usque 1 mm. latis, vix ciliata-scabridulis, scapis tantum usque 18 cm. altis, spica vix 5 mm. longa. Goyaz, Matto Grosso, et Paraguay (formae affines São Paulo, Minas Geraes et Guyana).

Xyris stenophylloides Malme, sp. nov. Caespitosa, gracilis, elata; scapi recti vel flexuosi subteretes, ecostati, laeves, vagina basalis eciliata, inferne ferrugineo-castanea, nitida; folia angustissima, scapo duplo breviora, vulgo spiraliter tortula, laeves; vagina sextam fere partem folii occupans, latiuscula, ligula distincta limitata, eciliata, inferne ferrugineo-castanea, nitida; spica satis multiflora, crasse subturbinata; bracteae tenuisculae, patulae, subintegerrimae, ferrugineae vel badiae, concolores, nitidulae intermediae late oblongae, sub apice rotundata obscure carinatae; sepala lateralia fere aequilatera, subpellucida, lineari-lanceolata, ala carinali subintegerrima, eciliata.

Scapi vulgo 30–40 cm. alti, 0.6–0.8 mm. crassi, vagina basalis vulgo 6–7 cm. longa, subaphylla; folia 15–20 cm. longa, 0.6–1 mm. lata, apice subulata, nervoso-striata, aciebus obtusis, vagina 2–3 cm. longa, jam superne lamina latior, deorsum sensim dilatata; spica vulgo 7–8 mm. longa; bracteae steriles paucae, infimae ovatae, circiter 1.5 mm. longae, fertiles (intermediae) circiter 6 mm. longae, usque 2.5 mm. latae; sepala lateralia libera, leviter curvata, circiter 5 mm. longa et 0.6 mm. lata, ala carinali praecipue superne latiuscula.

Growing in tussocks, gorge of Caño Negro, Savanna Hills, 4000 ft., *808.* Affinis esse videtur *X. stenophyllae* (in Rio de Janeiro, São Paulo, et Paraná occurrenti), quae recedit vagina foliorum pro rata longiore, ciliata, spica pauciflora, bracteis infimis multo longioribus et sepalibus lateralibus latioribus, ala carinali angusta.

Xyris Tatei Malme, sp. nov. Caespitosa, robusta, elata; scapi recti, ancipites, bicostati,laeves; folia rigida, ensiformi-linearia, scapo paullo usque duplo breviora, laevia, aciebus acutis, vagina circiter tertiam partem folii occupans, ligula distincte limitata, eciliata, inferne castanea, nitida; spica multiflora,

obovoideo-subglobosa, basi contracta; bracteae coriaceae, subintegerrimae, castaneae vel brunneae, concolores, nitidae, intermediae (fertiles) late oblongo-ovales, sub apice rotundato obtuse indistincteque carinatae, infimae (steriles) multo breviores; sepala lateralia subaequilatera, lineari-lanceolata, acuta vel acuminata, dorso castanea, ala carinali praecipue superne lata, fere inde a basi ciliata.

Scapi usque 70 cm. alti et 3 mm. lati, folia manifeste disticha, vulgo 35–45 cm. longa, 4–6 mm. lata, eciliata, apice falcato-incurvata et obtusiuscula; vagina 13–15 cm. longa, superne lamina paullulo angustior, deorsum sensim dilatata, carinata; spica 11–13 mm. longa; bracteae steriles numerosae, vulgo multifariam imbricatae, infimae triangulari-semiorbiculares, circiter 1.5 mm. longae, ceterae gradatim majores, fertiles (intermediae) circiter 8 mm. longae, 4–5 mm. latae; sepala lateralia libera, circiter 7 mm. longa, 1–1.25 mm. lata (Pl. 24, Fig. 1).

Moist slopes of Savanna Hills, 4400 ft., *778*, *835* (type). Habitu *Xyridem Augusto-Coburgi* Szyszyl. (in Itatiaya et Serra dos Orgãos, Rio de Janeiro, occurrentem) in memoriam revocat, at ei vix arctius affinis. Recedit haec foliis scabrido-ciliatis, vagina pro rata longiore (dimidiam fere partem folii occupante), bracteis spicae angustioribus, obtusis, opacis, sepalis lateralibus inaequilateris, obtusis, etc.

Ad speciem supra descriptam verisimiliter pertinet num. *417* (Slopes of Ridge 25; flower-stalks 3 ft. high; specimen unicum cum spica unica), foliis recedens tenuioribus et brevioribus, usque 6 mm. latis, tantum usque 20 cm. longis, vagina usque 7 cm. longa.

Xyris lugubris Malme, sp. nov. Caespitosa, satis robusta, humilior; scapi recti aliquantulum complanati, ecostati, laeves; folia rigida, ensiformi-linearia, scapo paullo breviora, laevia, aciebus obtusis, vagina circiter tertiam partem folii occupans, ligula distincte lacerata, eciliata, inferne spadicea, nitida; spica multiflora, obovoidea, basi paullum contracta; bracteae coriaceae, apice grosse laceratae nigricantes, concolores, opacae, intermediae (fertiles) ovales vel late oblongae, sub apice rotundato obtuse indistincteque carinatae, infimae (steriles) multo breviores; sepala lateralia anguste lanceolata, acuta, dorso castanea vel subspadicea, ala carinali angusta, in parte dimidia superiore ciliato-scabrida.

Scapi vulgo 20–30 cm. alti, circiter 1.5 mm. lati, folia manifeste disticha, vulgo 16–20 cm. longa, 2.5–3.5 mm. lata, acuta, stomatibus punctulata, eciliata (aciebus nonnunquam indistincte scabridulis), vagina 5–6 cm. longa, superne lamina paullo latior, inferne aliquantulum dilatata; spica 11–13 mm., raro usque 15 mm. longa; bracteae steriles numerosae, infimae ovato-triangulares, 2–3 mm. longae, ceterae gradatim majores, fertiles (intermediae) 7–8 mm. longae, usque 3 mm. latae; sepala lateralia libera, circiter 6 mm. longa, vix 1 mm. lata (Pl. 24, Fig. 1).

Summit of Peak 7, 7100 ft., *639*. Praecedenti affinis, at jam scapo ecostato, bracteis spicae laceratis, nigricantibus, opacis et ala carinali sepalorum lateralium angusta, tantum in parte dimidia superiore ciliata bene distincta.

Xyris atriceps Malme, sp. nov. Caespitosa, gracilis, satis elata; scapi recti, teretes, ecostati, laeves; folia recta vel leviter flexuosa, scapo paullo (usque duplo) breviora, teretia, subfiliformia, laevia, utroque latere sulco longitudinali angusto praedita, vagina circiter octavam partem folii occupans, jam superne lamina latior, eciliata, inferne castanea vel spadicea, nitida; spica satis pauciflora, obovoideo-turbinata, bracteae coriaceae, apice grosse laceratae, spadiceo-nigricantes vel atrae, concolores, opacae, intermediae (fertiles) late ovales vel obovato-ovales, sub apice rotundato obtuse et satis indistincte carinatae, infimae (steriles) fere duplo breviores; sepala lateralia aequilatera, lineari-lanceolata, acuta, castanea, ala carinali angusta, in parte dimidia superiore ciliato-scabridulae.

Scapi saltem usque 50 cm. alti, circiter 0.7 mm. crassi, vagina basalis subaphylla, usque 10 cm. longa; folia saltem usque 35 cm. longa, circiter 0.5 mm. lata, eciliata; vagina 3–4 cm. longa, basin versus sensim dilatata; spica circiter 9 mm. longa, usque 5 mm. crassa; bracteae steriles numerosae, patulae, infimae ovato-triangulares, circiter 2.5 mm. longae, ceterae gradatim majores, fertiles (intermediae) 4.5–5 mm. longae, usque 3.5 mm. latae; sepala lateralia libera, 4–4.5 mm. longa, circiter 0.8 mm. lata.

Forming tussocks, Ridge 15, 6700 ft., *688*. Praecedenti affinis, scapo gracili, foliis teretibus, subfiliformibus et spica magis pauciflora bene distincta.

Xyris Tatei, *X. lugubris*, et *X. atriceps* stirpem peculiarem, st. *Xyridis lugubris*, formant, bracteis spicae coriaceis, concoloribus, obscuris, ala sepalorum lateralium plus minusve ciliata, vagina foliorum breviuscula etc. dignotam, ex altera parte vix dubie stirpi *X. subulatae*, ex altera forsan stirpi *X. spectabilis* affinem. *X. atriceps* forma et structura foliorum a ceteris valde recedit, quoad spicam vero haud multum differt.

Xyris duidensis Malme, sp. nov. Caespitosa, humilis; scapi recti, ancipites, bicostati vel bialatis, in costis ciliato-scabriduli, ceterum laeves; folia ensiformi-linearia, saepe spiraliter torta et flexuosa, scapo vix breviora, acuta, laevia, aciebus paullulum cartilagineis, vagina plus quam dimidiam partem folii occupans, ligula distincta limitata, eciliata, basin versus brunnea vel castanea, nitidula; spica pauciflora, ovoideo-fusiformis; bracteae subcoriaceae, fulvae, opacae, intermediae (fertiles) obovatae, apice rotundatae et vulgo eroso-laceratae, area dorsali magna, carinata, cinereo-viridi vel sordide purpurascente ornatae, steriles paucae (vulgo 4), infimae lanceolatae, acutae, carinatae, apice primitus ciliatae (pilis longis, crispulis); sepala lateralia inaequilatera, lanceolata, acuta, ala carinali superne latiuscula et crebre ciliata.

Scapi vulgo 5–6 cm. alti, circiter 1 mm. lati; folia manifeste disticha, 4–5 cm. longa, 0.9–1.3 mm. lata, aciebus acutiusculis; vagina 3–3.5 cm. longa, basin versus paullum dilatata; spica 4–5 mm. longa, 2–2.5 mm. crassa; bracteae infimae 3–3.5 mm. longae, intermediae aequilongae, (explanatae) usque 2 mm. latae, apice vulgo sordide purpurascentes, area dorsali ovato-lanceolata; sepala lateralia libera, circiter 3 mm. longa, usque 0.9 mm. lata.

Gorge of Caño Negro, Savanna Hills, 4000 ft., *811* (type); streambed at Central Camp, *544*, 4800 ft., with yellow flowers. Species e stirpi *X. guianensis*, arcte affinis *X. rubrolimbatae* Heimerl—ad flumen Guiania (Rio Negro) lectae—quae recedit foliis latioribus, aciebus incrassatis, scapis subteretibus, spica crassiore et sepalis lateralibus linearibus, apice obtusis.

ABOLBODA GRANDIS Miq., var. **rigida** Malme, var. nov. Recedit a typo foliis rigidis, spica majore, bracteis et sepalis lateralibus longioribus.

Folia rigida, 12–17 cm. longa, 8–10 mm. lata, acuta, fere pungentia; scapi usque 85 cm. alti (vulgo tamen humiliores) et 2.5 mm. crassi, vaginis usque 4 cm. longis; spica usque 3.5 cm. longa; bracteae ovato-triangulares vel ovales, circiter 10 mm. longae, usque 5 mm. latae, acuminatae vel mucronatae, sepala lateralia usque 18 mm. longa et 5 mm. lata, acuta.

Scape 3 ft. high; flowers blue-purple, 1 in. in diameter, Brocchinia Hills, 4500 ft., *586* (type); Savanna Hills, 4400 ft., *1041*. Forma primaria: Surinam, Pará, Alto Amazonas (Manáos), Venezuela (ad Rio Negro), tantum in planitie depressa; var. *minor* Malme: Alto Amazonas (Manáos).

ABOLBODA SCEPTRUM Oliver. Folia rigida, 18–25 cm. longa, usque 4 cm. lata, acuta, subpungentia; scapus usque 90 cm. altus (vaginis oppositis nullis?); spica subglobosa vel fere semiglobosa, usque 7 cm. longa; bracteae ovato-triangulares, circiter 2 cm. longae et 1 cm. latae, acutae vel paullulum acuminatae; sepalum medianum (anticum) planum, ovato-lanceolatum, circiter 4.5 cm. longum, usque 1 cm. latum, acuminatum; sepala lateralia subaequilatera, ovato-lanceolata, circiter 5 cm. longa, usque 1 cm. lata, acuta vel acuminata, ala carinali angusta, subintegerrima. (Antherae speciminis e Roraima reportati sublineares, usque 10 mm. longae, circiter 1.5 mm. latae; filamentum anthera duplo longius).

Stems 3 ft. high; flowers yellow; crest of Ridge 25, 6300 ft., *398*. Cum speciminibus e Roraima reportatis bene congruit. Sepalo antico evoluto et corolla flava vel lutea a ceteris hujus generis speciebus recedens; forsitan novum genus sistat.

ERIOCAULACEAE

Lowland species

TONINA FLUVIATILIS Aubl. Along the Casiquiare River, Venezuela, *165*; widely distributed and very common at low altitudes throughout tropical South America.

PAEPALANTHUS FASCICULATUS (Rottb.) Koern. Under rocks on Esmeralda Ridge, *229*, *274;* widely distributed and common through tropical America.

SYNGONANTHUS CAULESCENS (Poir.) Ruhl. East Swamp at Esmeralda, *246;* a common plant in tropical South America.

SYNGONANTHUS GRACILIS (Koern.) Ruhl. East Swamp at Esmeralda, *259;* sandy swamp on Esmeralda Ridge, *216;* native of northern South America.

SYNGONANTHUS HUBERI Ruhl. In an open sandy swamp at Camanaos, on the Rio Negro, northern Brazil, *123;* hitherto known only from the type collection from the upper Amazon.

SYNGONANTHUS HUMBOLDTII (Kunth) Ruhl., var. **glandulosus** Gleason, var. nov. A forma typica differt pedunculis molliter glanduloso-villosis; caulibus elongatis gracillimis glabris vel summo puberulis; foliis fasciculatis angustissime linearibus basi lanatis; pedunculis compluribus elongatis.

In moist parts of the Grand Savanna, Esmeralda, *315*. The basal leaves are 15 to 25 mm. long and 3 to 4 times as long as the cauline.

Syngonanthus reflexus Gleason, sp. nov. Caule abbreviato villoso; foliis rosulatis crassis erectis linearibus acutis glabris supra sulcatis subtus rotundatis; vaginis acuminatis dimidium foliorum aequantibus glabris; pedunculis paucis elongatis glabris leviter tortis obscure 9-sulcatis; capitulis mediocribus campanulatis stramineis; bracteis involucrantibus numerosis eleganter spiraliter imbricatis infimis late oblongis interioribus gradatim elongatis intimis oblongo-linearibus, omnibus basi appressis dorso subtomentosis apice in appendicem linearem glabram retroflexam subito acuminatis; petalis florum femineorum linearibus elongatis villosis; stylo breve, stigmatibus 3 simplicibus non appendiculatis.

Stem very short, densely villous among the leaf-bases; leaves rosulate, erect, thick and firm, linear, 50 to 75 mm. long, 1.5 to 2 mm. wide, acute, sparsely villous when young, soon becoming glabrous, deeply sulcate above, rounded beneath, slightly twisted; vaginas about half as long as the leaves, glabrous, slightly dilated above, acuminate; peduncles 2–4, erect, 25–35 cm. tall, slender, glabrous, slightly twisted, shallowly 9-sulcate; heads campanulate, 8 mm. high, including the projecting corollas; outer bracts very numerous, beautifully spirally imbricate in many series, closely appressed and subtomentose on the back at base, abruptly acuminate above into a linear-subulate, glabrous, recurved appendage, the outermost broadly oblong, the inner progressively elongate, the innermost linear-oblong; pistillate flowers: sepals scarious, linear-subulate, 2.5 mm. long, 0.3 mm. wide at base, glabrous; petals scarious, erect, filiform, 4.5 mm. long, densely long-villous throughout, the distal 1 mm. very narrowly lanceolate; ovary ellipsoid, 0.9 mm. long; style straight, 0.5 mm. long; stigmas 3, erect, 1.3 mm. long, filiform, simple; append-

ages none; seeds nearly cylindric, 1.1 mm. long by half as thick, slightly asymmetrical, surmounted by a brown ring, slightly retuse at the truncate summit; staminate flowers entirely glabrous: sepals linear, 3.3 mm. long, scarious, acute; petals connate to the middle, 3.7 mm. long, the lobes lanceolate, acute; pistil rudimentary.

In swampy ground at the Grand Savanna, Esmeralda, *305*. The species is a member of the section *Thysanocephalus* Koern., as shown by its campanulate heads and imbricate bracts. Among the species of this section, its nearest allies appear to be *S. centauroides* (Bong.) Ruhl. and *S. squarrosus* Ruhl., both of Minas Geraes and both lacking the prominently reflexed bracts of our species.

SYNGONANTHUS SIMPLEX (Miq.) Ruhl. East Swamp at Esmeralda, *248;* a widely distributed species of northern South America.

SYNGONANTHUS (?) sp. An unidentifiable plant with very immature flowers, in swampy ground, Grand Savanna, Esmeralda, *300*.

Species of Mount Duida

PAEPALANTHUS CAPILLACEUS Klotzsch, var. **proliferus** Gleason, var. nov. Capitulis apice in folia rudimentaria filiformia basi dilatata proliferentibus.

Essentially like the species, except the heads subglobose and the outer bracts acute; each head proliferating at its center into 6–20 rudimentary leaves surrounded by a mass of villous hairs 2 mm. long, each leaf filiform, nearly terete, 10–15 mm. long, 0.3 mm. wide, yellowish, slightly constricted 2–4 mm. above the base, its base flattened, very thin and delicate, obovate, 1.3 mm. long, 0.9 mm. wide, truncate or slightly retuse.

On rocks under water in stream-bed, Central Camp, 4800 ft., *552*.

Paepalanthus convexus Gleason, sp. nov. Caule elongato simplice dense folioso; foliis confertis demum reflexis basi villosis linearibus subrigidis, juventute sparse villosis mox glabrescentibus; pedunculis pluribus pluristriatis tortis hirtellis; capitulis mediocribus cinereis, bracteis arcte imbricatis ovatis vel rotundatis apiculatis dense pubescentibus; bracteis stipantibus oblongis acutis nigrescentibus; flores masculi: sepalis obovato-oblongis obtusis apice villosis; corollae infundibuliformis lobis ovatis; antheris vix exsertis dithecis; flores feminei: sepalis latioribus obovatis obtusis apice dense villosis; petalis liberis oblongis dense villosis; stigmatibus brevibus bifidis appendicibus linearo-clavatis alternantibus.

Stems elongate, as much as 40 cm. long, stout, 4 mm. in diameter, densely leafy above and villous when young, denuded in age but permanently scaly with the persistent leaf-bases, unbranched; leaves crowded above, soon becoming reflexed, firm, ensiform-linear, 2–3 cm. long, 2 mm. wide, gradually tapering to an apparently acute but actually obtuse tip, sparsely villous when young, especially along the margin, soon becoming glabrous, about 9-ribbed; peduncles terminal, 2–7, 10–15 cm. long, slightly twisted, 3-sulcate, each of

the costae about 3-ribbed, glabrous in the furrows, hirtellous on the costae; vaginas equaling the upper leaves, acuminate, the orifice oblique and densely ciliate, the tube glabrous or hirtellous; heads cinereous, hemispheric, 7–8 mm. in diameter; involucral bracts spreading horizontally, imbricate, dark-brown, densely pubescent, prominently apiculate above the rounded summit, the outer broadly ovate, the inner rotund and as much as 2.5 mm. long; receptacle conic, 2 mm. high; subtending bracts oblong, 2 mm. long, 0.6 mm. wide, sharply acute or subacuminate, nigrescent, densely villous toward the tip; staminate flowers: sepals obovate-oblong, 1.6 mm. long, 0.7 mm. wide, obtuse, nigrescent, densely hirsute distally; corolla funnel-form, 1.8 mm. long, the ovate lobes equaling the tube; anthers 3, barely exserted, broadly ellipsoid, dithecous; gynoecium reduced to 3 short stout subterete rudiments; pistillate flowers: sepals obovate, 2 mm. long, 1.1 mm. wide, rounded above, nigrescent, densely hirsute distally; petals free, oblong, broadest above the middle, 2 mm. long, 0.6 mm. wide, subacute, densely hirsute within, the basal hairs 2.6 mm. long, the upper gradually reduced and all ending at about the same height; ovary stoutly ellipsoid, 0.7 mm. long; style stout, 0.8 mm. long; stigmas 3, erect, 0.9 mm. long, bifid to the middle, alternating with 3 linear-clavate appendages which are 0.9 mm. long.

First ridge, summit of Peak 7, 7100 ft., *658* (type); crest of Ridge 25, 6300 ft., with erect-ascending stems two feet long, *470*. It is a member of the subgenus *Paepalocephalus* Ruhl., section *Eriocaulopsis* Ruhl., although this section is described with a flat receptacle. Its exact position in this large section is questionable, because of its receptacle, but it apparently should be referred to the subsection *Polyactis* Ruhl.

Paepalanthus duidae Gleason, sp. nov. Caule abbreviato dense folioso; foliis anguste linearibus rigidis crassis glabris obtusis; vaginis folia aequantibus; pedunculis 6-costatis glabris; capitulis magnis, bracteis externis oblongo-ellipticis nigrescentibus obtusis; pedicellis brevibus bracteis lineari-oblongis flores aequantibus instructis; flores feminei: sepalis obovato-oblongis; petalis anguste obovato-oblongis liberis; stylo breve; stigmatibus elongatis bifidis appendicibus capitatis alternantibus; flores masculi: sepalis obovatis; petalis ad medium connatis apice inflexis; gynoecio rudimentario.

Stem abbreviated or in age somewhat elongate, densely tomentose; leaves densely tufted, very numerous, thick and rigid, somewhat recurved, narrowly linear, strongly ribbed, sharply acute, strictly glabrous, 4–6 cm. long, 1 mm. wide; peduncles 1–3, 20–25 cm. tall, 6-costate, straight or somewhat twisted, glabrous, their sheaths acute, divergent above, about equaling the leaves; heads about hemispheric, 13–18 mm. in diameter, densely woolly; outer bracts black, oblong-elliptic, 5–6 mm. long, 1.7 mm. wide, obtuse, white-hirsute distally, becoming nearly glabrous in age; inner bracts black above the middle, with a conspicuous yellow midrib, narrowly linear-oblong, curved around the flowers; 5.0 mm. long, 1.0 mm. wide, abruptly and sharply acuminate, densely

villous on the back distally; pistillate flowers: pedicels slender, glabrous, 1.7 mm. long; sepals scarious, obovate-oblong, 3.2 mm. long, 1.2 mm. wide, obtuse; petals narrowly obovate-oblong, free, 3.2 mm. long, 0.8 mm. wide, obtuse; ovary thick-ellipsoid, 3-angled, 1.0 mm. long; style stout, straight, 0.7 mm. long; stigmas 3, very slender and incurved, nearly 2 mm. long, bifid to the middle, alternating with 3 capitate appendages 0.7 mm. long; staminate flowers: lateral sepals narrowly obovate, slightly inequilateral and falcate, 2.6 mm. long, 0.9 mm. wide, obtuse, black, sparsely long-hirsute distally; dorsal sepal similar but equilateral; petals connate to the middle, 4 mm. long, the tip strongly incurved to form an obconic corolla 2.4 mm. long; gynoecium reduced to 3 clavate-spatulate rudiments.

Slopes of Ridge 25, 5500–6000 ft., *456* (type); forming tussocks at Caño Sapo, 6300 ft., *691;* summit of Peak 7, 7100 ft., *625.* The species is obviously related to *Paepalanthus roraimae* Oliver and resembles it in general habit. The Roraima plant is distinguished by its acute bracts, hirsute peduncles, vaginas much exceeding the leaves, and blunt leaves only 2–3 cm. long.

Paepalanthus robustus Gleason, sp. nov. Caule elongato dense folioso erecto; foliis patulis rigidis ensiformi-linearibus acutis juventute longe ciliatis, praesertim ad basin arcte amplectentem; vaginis folia aequantibus hirtellis apice obliquis longe ciliatis acuminatis; pedunculis solitariis leviter tortis hirtellis; capitulis magnis cinereis; bracteis involucrantibus rigidis brunneis late triangulari-ovatis acutis, basi adpressis glabris, apice subpatulis pubescentibus; bracteis stipantibus oblongo-spathulatis nigrescentibus summo villosis; flores staminei: sepalis obovato-oblongis nigrescentibus apice dense villosis; corollae tubulosae lobis anguste ovatis acuminatis; flores feminei: sepalis anguste obovato-oblongis obtusis apice villosis; petalis liberis anguste oblongis obtusis tota longitudine dense villosis; stigmatibus quam appendicibus clavatis multo longioribus.

Stems stout, erect, at least 15–20 cm. tall, completely covered by the leaves; leaves thick and rigid, yellowish green, erect or spreading, ensiform-linear, 40–55 mm. long, 3–5 mm. wide, acute, glabrous on the sides, sparsely ciliate when young, entire at maturity, their bases closely appressed, somewhat dilated, and densely long-ciliate; vaginas equaling the leaves, hirtellous, acuminate, the orifice oblique, acuminate, densely villous-ciliate; peduncles stout, about 30 cm. long, hirtellous, lightly twisted, irregularly costate; heads hemispheric, 16 mm. in diameter, cinereous; outer bracts rigid, brown, imbricate in several series, broadly triangular-ovate, acute, as much as 6 mm. long, closely appressed and glabrous at base, erect or slightly spreading and pubescent above; receptacle flat; subtending bracts narrowly oblong-spatulate, 3.3 mm. long, 0.7 mm. wide above, acute, scarious below, nigrescent above, densely villous on the distal third; staminate flowers: sepals obovate-oblong, 2.2 mm. long, 0.7 mm. wide, obtuse, nigrescent above, densely villous on the

back distally, the two lateral ones slightly falcate; corolla tubular, the tube 2 mm. long, the lobes narrowly ovate, 0.8 mm. long, acuminate, not inflexed; stamens not seen; pistillate flowers: sepals narrowly obovate, 2.9 mm. long, 0.9 mm. wide, rounded at the tip, sparsely hairy below, densely villous on the distal fourth; stigmas 3, much exceeding the linear-clavate alternating appendages which are 0.6 mm. long.

Summit of Peak 7, 7100 ft., *622*. It is obviously closely related to *P. convexus* Gleason, but is much larger in all its dimensions; it is similarly closely related to *P. subcaulescens* Brown, which has broader leaves and much smaller heads.

SYNGONANTHUS GRACILIS (Koern.) Ruhl. Gorge of Caño Negro, Savanna Hills, 4000 ft., *813;* a native of northern South America.

SYNGONANTHUS TRICOSTATUS Gleason. Gorge of Caño Negro, Savanna Hills, 4000 ft., *809;* also known from Mount Roraima, its type locality.

Leiothrix turbinata Gleason, sp. nov. Caule paullum elongato dense folioso; foliis mollibus suberectis confertis ensiformi-linearibus acutis villosis; vaginis foliis multo brevioribus hirsutis oblique fissis; pedunculis 4-costatis villosis; capitulis parvis turbinato-campanulatis; bracteis involucrantibus imbricatis adpressis late ovatis acutis pubescentibus; bracteis stipantibus lineari-oblanceolatis acutis pubescentibus; flores staminei: sepalis oblongo-ellipticis acutis apice breviter pubescentibus; petalis in tubum obconicum summo 3-lobatum connatis glabris; antheris exsertis 2-thecis; floribus femineis nondum evolutis.

Stems somewhat elongate, 8–10 cm. long, densely leafy; leaves soft, ensiform-linear, 6–8 cm. long, 5 mm. wide, acute, persistently villous; vaginas much shorter than the leaves, hirsute, the summit oblique, acuminate; peduncles 3–6, 18–25 cm. high, shallowly 4-sulcate, barely twisted, villous; heads blackish, turbinate-campanulate, 4 mm. high, 6 mm. in diameter; outer bracts appressed, dark brown, regularly imbricate in several series, the exposed tips broadly triangular-ovate, acute, thinly pubescent; receptacle concave, villous; subtending bracts linear-oblanceolate, 2.7 mm. long, 0.5 mm. wide, curved inward at the abruptly acuminate tip, densely short-pubescent toward the tip and somewhat so below; staminate flowers; sepals oblong-elliptic, 2.3 mm. long, 0.7 mm. wide, acute, scarious, glabrous below, densely short-pubescent on the distal fourth; petals connate into a narrowly obconic tube 1.9 mm. long, 3-lobed at the summit; filaments well exserted; anthers dithecous; pistillate flowers immature.

Moist slopes of Savanna Hills, 4400 ft., *775* (type); between Ridge 16 and Caño Sapo, 6300 ft., *692*. The latter has larger leaves, as much as 8 mm. wide. It is apparently related to *L. nubigena* (Kunth) Ruhl., of Minas Geraes, which has much smaller leaves, glabrous peduncles, and acuminate outer bracts.

RAPATEACEAE

Lowland species

CEPHALOSTEMON AFFINIS Koernicke. Open savanna swamp at Esmeralda, no. 176. It is known only from this locality, where it was originally collected by Spruce.

Monotrema xyridoides Gleason, sp. nov. Foliis distichis paucis; vaginis patulis anguste triangularibus gradatim angustatis; laminis linearibus obtusis; scapis gracilibus sulcatis; capitulo unico ovoideo obtuso; bracteis externis 2 brevibus ovatis obtusis; bracteis subtendentibus numerosis ovatis obtusis flores subamplectentibus et contegentibus; bracteis floralibus 10, ovato-lanceolatis subaequalibus; sepalis triangulari-lanceolatis; capsula ovoidea truncata; seminibus rhomboideis complanatis rostratis.

Leaf-sheaths narrowly triangular, castaneous, 8 cm. long, 9 mm. wide at base, gradually tapering to a rounded, closely appressed or adnate tip; blades linear, about 25 cm. long, 6–7 mm. wide, bluntly rounded and subcartilaginous at tip, 5-striate on one side of the midvein, 6-striate on the other; peduncular sheath about 6 cm. long; scapes erect, 45–55 cm. tall, 1 mm. in diameter, 5–6-sulcate, gradually enlarged near the summit to 2.5 mm. in diameter; heads solitary, broadly ovoid, 15 mm. long, 10 mm. in diameter, blunt or rounded above, castaneous; outer bracts 2, broadly ovate, coriaceous, obtuse, 8 mm. long; flowers about 25, each subtended, partly enclosed, and largely concealed by a subtending bract which is broadly ovate, about 7 mm. long, coriaceous, obtuse or rounded, often split at end at maturity; flowers ovoid, about 6 mm. long; floral bracts about 10, ovate-lanceolate, obtuse, 4.4–5.5 mm. long; sepals triangular-lanceolate, acute, 5.1 mm. long; capsule horny in consistency, pale yellow, ovoid, truncate at summit, 3.5 mm. long, 3-celled and 3-seeded, each valve swollen at base over the seed and prismatic-trigonous above; seeds brown, rhomboid, flattened, 1 mm. long and nearly as wide, with an erect beak 0.5 mm. long (Pl. 25).

East Swamp at Esmeralda, *245*. The remarkable feature of the species is the presence of a subtending bract at the base of each flower, nearly as large as the two involucral bracts at the base of the head, and practically concealing the flowers. The head accordingly greatly resembles that of a *Xyris*, whence the specific name. Apart from this structure, there is no doubt of its affinity with *Monotrema*. It is apparently nearest to *M. aemulans* Koern., which also has short outer bracts, obtuse inner bracts, slender sulcate peduncles, and obtuse leaves.

Species of Mount Duida[1]

Amphiphyllum Gleason, gen nov.

Involucri folia 3 (an semper?) erecta, primo complicato lato secundum complicatum occludente, tertio parvo plano. Flores circiter 10 capitati sessiles.

Bracteae circiter 20 erectae acuminatae. Sepala bracteiformia. Antherae lineari-subulatae apice acuminatae poro obliquo terminali-introrso dehiscentes. Ovarium 3-loculare ovulis in quoque loculo 2 superpositis.

Scapose herbs, the leaves with short sheath and linear multicostate blades. Involucre of 3 (possibly in other heads only 2) erect bracts, the outer covering the whole head, strongly folded, carinate on the back, apparently splitting down the back at anthesis, the second narrower and folded, the third much smaller and flat. Flowers about 10, sessile and capitate. Bracts on each flower about 20, all oblong-lanceolate and sharply acuminate, the outer two-thirds as long as the longest, which slightly exceed the innermost. Sepals with blades resembling the inner bracts. Petals sharply acute or short-acuminate. Stamens 6, the anthers linear-subulate, acuminate, opening by a single oblique terminal-introrse pore. Ovary conic, 3-celled, the ovules two in each cell, superposed.

The name refers to the bracts which closely surround the head.

Amphiphyllum rigidum Gleason, sp. nov. Foliorum vaginis anguste triangulari-ovatis apice acutis; laminis elongatis rigidis linearibus acutis pluricostatis; scapis erectis glabris sicco angulatis superne complanatis paullum dilatatis; involucri foliis ovatis acuminatis; bracteis oblongo-lanceolatis.

Leaf-sheaths carinate, strongly folded, triangular-ovate, each half about 13 mm. wide and at least 6 cm. long, tapering regularly to the acute tip; blades thick and rigid, narrowly linear, sharply acute, about 9-ribbed, 6–9 mm. wide, about 9 dm. long; scapes at least 6 dm. high, strongly angled below when dry, flattened and expanded toward the top and 8 mm. wide at the apex; outer leaf of the involucre as much as 40 mm. long by 32 mm. wide, broadly

[1] Having already observed the single common species of this family at Mount Roraima, my interest was at once awakened on Mount Duida by the remarkable differentiation of these plants, to which we gave the name "strap-leaf." The species first observed on Ridge 25, *Stegolepis guianensis*, appeared to be identical with that of Roraima. Nearby grew the very much larger *Stegolepis pauciflora*, with stouter leaf-bases and broader blades. This species, which was perhaps the most abundant and widespread of them all, grew upon most of the crests and upper slopes of the plateau, seeming to prefer moist or boggy spots. *Stegolepis pungens*, first noted at Brocchinia Hills and Savanna Hills, and the narrow-leaved *Stegolepis linearis* have a peculiar property. While the glossy leaves of practically all members of the family reflect light strongly, in these two species the leaves reflect the blue of the sky like water does. My Indians, when cutting trail to High Point, reported on Ridge 16 a "grass with blue leaves." The next evening they brought in a specimen of this plant (*S. linearis*). Since the daylight had almost gone, the leaves appeared no less green than any others. It was not until later that I was able to observe the phenomenon of reflection for myself. This narrow-leaved plant is rather scarce, being found only on Ridge 16 and Savanna Hills. Another interesting species is *Saxo-Fridericia regalis*, with leaves 5 meters in length, which I found only in Camp Woods at Savanna Hills. The plant is entirely dependent upon adjoining vegetation for the support of its unwieldy leaves. It was not flowering when discovered.—G.H.H.T.

ovate, sharply acuminate, carinate on the back, veinless, its base covering nearly the whole head and its outer edges adjacent below; second leaf similar, ovate-lanceolate, 26 mm. long, 13 mm. wide; third leaf flat, oblong-lanceolate, 21 mm. long, 7 mm. wide; flowers about 10, sessile, crowded on a flat receptacle, 21 mm. long before anthesis; bracts about 20, all erect, appressed only at base, oblong-lanceolate, sharply acuminate, the outermost 13 mm., the largest 18 mm., the innermost 15 mm. long; flowers in the specimen not yet expanded, the claws of the sepals and petals and the filaments therefore not yet elongated (Pl. 25).

In a swamp on the slopes of the Savanna Hills, 4400 ft., *780.* Unfortunately our specimen does not show fully developed flowers so that measurements of the flower-parts have not been given. The characters observed are nevertheless sufficient to separate it from all other genera of the family, of which only eight others are known. Of these, only *Saxo-Fridericia*, *Schoenocephalium*, and *Stegolepis* have two or more ovules in each cell of the ovary. In the first of these three the two bracts of the involucre are connate into a sac surrounding the flowers and the anthers open by a longitudinal cleft; in the second the involucre is smaller, the bracts are obtuse, and the anthers open by two pores. In the third there is no involucre and the outermost bracts are greatly reduced in size. *Stegolepis* stands nearest to our genus, resembling it in vegetative habit and anthers.

Saxo-Fridericia regalis Schomb. Savanna Hills, 4400 ft., *795;* hitherto known only from high altitudes on Mount Roraima and from lower elevations in the sandstone region of British Guiana. Its leaves, which are only 30–35 mm. wide, attain a length of four meters, as evidenced by the dry specimens, or of nearly five meters, according to the field notes of Mr. Tate.

The genus *Stegolepis* has hitherto included three species, all endemic to the sandstone region of British Guiana, where the original species was first collected by Schomburgk at high altitudes on Mount Roraima. The other two are limited, so far as known, to the Kaieteur Savanna. Three others are now to be added from Mount Duida. The distinguishing characters of the six are shown in the following brief key:

Flowers very numerous in a dense head, radiating in all directions from the summit of the scape.
- Leaf-sheaths obtuse, rounded or auriculate at the summit.
  - Flowers, excluding the petals, 12–15 mm. long; scapes conspicuously flattened at the summit ... *S. guianensis* Kl.
  - Flowers, excluding the petals, 7–8 mm. long; scapes very slender, scarcely flattened ... *S. ferruginea* Baker.
- Leaf-sheaths gradually narrowed to the summit ... *S. angustata* Gl.

Flowers 1–10, the scape strongly flattened above, rounded at the summit, and bearing a solitary flower, or 2–10 flowers in a single row, radiating fanwise.
Leaf-sheaths tapering gradually to the blade *S. linearis* Gl.
Leaf-sheaths broad, abruptly rounded to the summit.
Flowers 1 or 2, as much as 17 mm. long excluding the corolla; bracts obtuse or subacute; leaf-sheaths opaque, auricled at the summit *S. pauciflora* Gl.
Flowers 6–10, as much as 32 mm. long excluding the corolla; bracts sharply acuminate; leaf-sheaths shining, rounded at the summit *S. pungens* Gl.

STEGOLEPIS GUIANENSIS Klotzsch. Crest of Ridge 25, alt. 6300 feet, with scape five feet high, *399*. The specimen is referred here with some doubt, since the characteristic leaf-sheaths are not present. It has been known hitherto only from the summit and upper slopes of Mount Roraima.

Stegolepis linearis Gleason, sp. nov. Foliis distichis dense confertis; vaginis adpressis anguste triangularibus ad apicem angustatis; laminis linearibus elongatis crassis rigidis; scapis inferne gracilibus superne dilatis complanatis et ad laterem unum obscure carinatis; floribus 1–3 involucro nullo sessilibus; bracteis brunneis glabris adpressis induratis, extimis triangularibus, mediis obovato-oblongis, intimis oblongis, omnibus acutis; antheris linearibus apice poro unico introrso dehiscentibus; ovarii loculis 3-spermis.

Leaves distichous, the basal sheaths crowded in a dense cylindric cluster 3 cm. in diameter, 10–12 cm. long, 5 cm. wide at base, somewhat carinate, tapering regularly to the acute summit; blades exceedingly rigid and more or less twisted, narrowly linear, 6–8 mm. wide, 50–70 cm. long, 9-ribbed, narrowed above to an obtuse apex; scapes 40–80 cm. high, erect, slender and subterete below, gradually expanded and flattened near the summit and at the top 3–10 mm. wide, depending on the number of flowers, the summit obscurely carinate on one side only; involucre none; flowers sessile, stoutly fusiform, 10–12 mm. long, 7 mm. in diameter; bracts about 20–25, arranged in 6 rows, the outermost triangular, 3 mm. long, the next broadly ovate, and successive bracts gradually elongating to as much as 9 mm. and obovate-oblong to oblong in shape, all closely appressed and acute; claw of the petals 7 mm. long, the blade broadly flabellate, about 20 mm. long and wide; filaments flat and scarious below, where they are adnate to the corolla, slender above, 11 mm. long at anthesis; anthers linear, acuminate, opening by a single subterminal introrse pore; ovary conic, 3-celled, with 3 ovules superposed in each cell; style slender, 17 mm. long; stigma punctiform (Pl. 25).

On Peak 15, 6700 ft., *574* (type); in a swamp on the slopes of the Savanna Hills, 4400 ft., *734*, *781*. The description of the flower is from *734*, which alone displayed expanded flowers.

Stegolepis pauciflora Gleason, sp. nov. Foliorum vaginis complicatis late ovatis apice auriculatis; laminis late linearibus crebre venosulis; scapis elongatis glabris summo vix expansis, involucro nullo nisi bracteis 2 infimis quam vicinis parce majoribus; floribus 1 vel 2, sessilibus mediocribus; bracteis in-

erne triangularibus usque intimis oblongo-lanceolatis, omnibus viridibus aut stramineis adpressis obtusis vel subacutis; sepalis basi longe unguiculatis laminis oblongo-lanceolatis exsertis; petalis unguiculatis, laminis rotundis patulis; filamentis ad basin corollae adnatis scariosis; antheris subulatis poro terminale introrso dehiscentibus.

Leaf-sheaths distichous and closely imbricated, 15 cm. long, carinate on the back, each half ovate-oblong, 6 cm. wide, somewhat narrowed above and ending in a broad rounded auricle prolonged 20–25 mm. above the base of the blade, the surface opaque and essentially veinless, the margin membranous or subscarious; blade about 70 cm. long, 25 mm. wide at base, increasing to 50 mm. 15 cm. above the base, thence very gradually tapering to the obtuse tip, finely many-nerved; scapes about equaling the leaves in height, slender and somewhat bicarinate below, slightly expanded and flattened above, 5 mm. wide at the summit when 2-flowered; involucre none, but in 2-flowered heads the two lowest bracts are slightly larger than those immediately above them; flowers 1 or 2, sessile; bracts gradually changing from broadly triangular and 3 mm. long at the base to oblong-lanceolate and 13 mm. long above, all obtuse or subacute; sepals exserted at anthesis, the oblong claw 8.5 mm. long, the oblong-lanceolate, spreading or reflexed blade 17 mm. long; petals yellow, spreading, the claw 10 mm. long, the rotund (?) blade 20 mm. long and wide; filaments thin and flat, 12 mm. long, adnate to the corolla at base; anthers linear-subulate, 10 mm. long, opening by a single terminal introrse pore (Pl. 25).

Summit of Ridge 22A, *1008*, bearing 2-flowered heads (type); crest of Ridge 25, 6300 ft., *527*, the specimen consisting of the tops of 1-flowered scapes only.

Stegolepis pungens Gleason, sp. nov. Foliorum vaginis complicatis late ovatis nitentibus superne rotundatis; laminis crassis rigidis late linearibus venosulis obtusis; scapis elongatis complanatis pluricostatis apice dilatatis rotundatis; involucro nullo nisi duabus cicatricibus linearibus; floribus 6–10 sessilibus usque 32 mm. longis corolla delapsa; bracteis extimis ovato-triangularibus superioribus majoribus ovato-oblongis acutis intimis oblongo-lanceolatis acuminatis, omnibus ferrugineis; sepalis longe unguiculatis laminis exsertis oblongo-lanceolatis acuminatis; petalis unguiculatis laminis basi cuneatis; filamentis basi alte connatis in tubum ovarium cingentem partibus liberis scariosis; ovario stipitato conico-ovoideo acuto; stylo terete basi tumido.

Leaf-sheaths coriaceous, smooth and shining, each half broadly ovate, 9 cm. wide with membranous margins, veinless, rounded at the summit; leaf-blades thick, rigid, broadly linear, 20–25 mm. wide at the base, with maximum width of 65 mm. 15 cm. above the base, nearly 5 dm. long, obtuse, with numerous fine nerves; scapes as much as a meter high, flattened, many-costate, dilated at the top and ending in a rounded, almost semicircular tip; involucre none, but the summit of the scape is marked by two elongate, narrow, over-

lapping membranes 1 mm. wide; flowers 6–10, sessile, as much as 32 mm. long without the corolla; bracts brown, indurated, appressed at base, the tips slightly spreading, the lowest triangular, 5 mm. long, the upper changing to ovate-oblong and finally oblong-lanceolate, the uppermost 22 mm. long; claw of the sepals 12 mm. long, 3 mm. wide, the oblong-lanceolate acuminate blade 13–14 mm. long; claw of the petals 10 mm. long, the base of the blade (now badly broken) broadly cuneate; filaments 10 mm. long, their broadened bases connate for 7–8 mm. into a tube surrounding the ovary, the short free portion flat and scarious; anthers fallen; ovary on a stout obconic dark brown stipe 1.5 mm. long, itself stoutly ovoid, acute, 4 mm. long, marked with three longitudinal stripes, 3-celled, each cell with 6 or 8 ovules; style slender, 15 mm. long, minutely swollen at base; stigma punctiform; capsule loculicida (Pl. 21, 25).

Savanna Hills, 4400 ft., *1043* (type, with corollas still persisting); Brocchinia Hills, 4500 ft., *591* (past bloom). On both specimens the full length of the sheath is not determinable; it is at least 14 cm. long. The four heads bear respectively 6, 7, 8, and 10 flowers.

BROMELIACEAE[1]

Lowland species

Brocchinia prismatica L. B. Smith, sp. nov. Metralis: foliis ad 40 cm. longis, laminis a vaginis vix distinctis, anguste triangularibus, involutis, 2–3 cm. latis, lepidibus minutissimis obtectis, conspicue lacunosis; scapo erecto, vaginis foliaceis internodos superantibus obtecto; inflorescentia laxe bipinnata; bracteis primariis parvis, lanceolato-acuminatis; racemis gracilibus, ca. 20 cm. longis, laxe multifloris; bracteis florigeris minutis, pedicellos subaequantibus; floribus erectis, in pedicellos sensim transeuntibus; sepalis 4.5 mm. longis; staminibus liberis; capsula circuitu elliptica, 1 cm. longa, bene triangulatim prismatica; seminibus utroque polo ala angusta auctis.

Almost a meter high; leaves rosulate, 40 cm. long, scarcely any distinction between the blade and the sheath, blade narrowly triangular, involute, 2–3 cm. wide, minutely appressed-lepidote, appearing glabrous to the naked eye, lower surface definitely lacunose: scape erect, slender, terete, glabrous, its bracts leaf-like and exceeding the internodes; inflorescence laxly bipinnate; primary bracts small, lance-acuminate, scarcely attaining the lowest flower of the raceme; racemes slender, about 20 cm. long, laxly many-flowered; floral bracts minute, about equaling the flower-pedicels; flowers erect, gradually tapering below into the pedicels; sepals 4.5 mm. long; stamens free, shorter than the petals; capsule elliptical in outline, almost wholly inferior, 1 cm. long, strongly three-angled; seeds flat with a narrow wing at either end (Fig. 3).

Swampy ground, Grand Savanna, section 1, Esmeralda, *281*. This species is quickly distinguished from the others of the genus by its broad

[1] By L. B. Smith.

strongly three-angled capsule. With *B. reducta* it shares the peculiar character of lacunose leaves.

PITCAIRNIA NUDA Bak. Rocky top of Esmeralda Ridge, Esmeralda, *213;* also in British and Dutch Guiana.

TILLANDSIA ALOIFOLIA Hook. On rocks and trees, summit of Esmeralda Ridge, *228;* ranging from southern Florida and the West Indies to Panama and the coasts of Colombia, Venezuela, and the Guianas, usually near sea-level.

Species of Mount Duida

BROCCHINIA REDUCTA Bak. Moist slopes of Savanna Hills, 4400 ft., *846*.[1]

The following which consist of leaves only undoubtedly belong here because of the rounded-apiculate summit and lacunose surface; summit of Peak 7, 7100 ft., *618;* Central Camp, 4800 ft., *576a;* ridge northwest of Vegas Brook, 4400 ft., *569*.

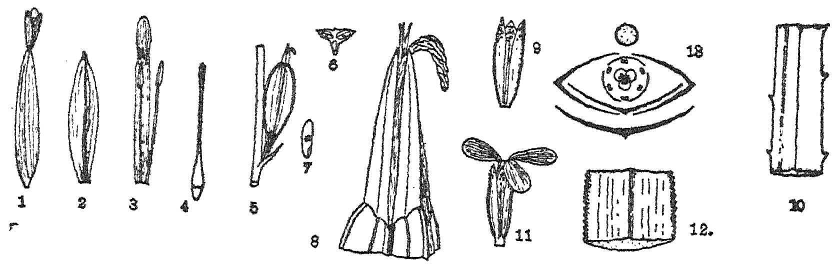


Fig. 3.

1—4. *Tillandsia duidae.* 1. Flower. 2. Sepal. 3. Petal and stamens. 4. Pistil. All natural size.

5—8. *Brocchinia prismatica.* 5. Flower. 6. Cross-section of ovary. 7. Seed. 8. Summit of flower, ×5; all others natural size.

9, 10. *Navia duidae.* 9. Abaxial view of sepals, natural size. 10. Section of leaf, ×5.

11, 12. *Navia brachyphylla.* 11. Abaxial view of flower, natural size. 12. Section of leaf, ×5.

13. Floral diagram of *Navia duidae* and *N. brachyphylla.*

Navia duidae L. B. Smith, sp. nov. Bene caulescens, ad 9 cm. alta; foliis angustissime linearibus, 9 cm. longis, 3 mm. latis, remote minuteque spinulosis, subtus cinereo-lepidotis; inflorescentia simplici, capituliformi, in foliorum

[1] *Brocchinia reducta* frequents boggy spots on slopes where the soil as a rule is thin. It was common at Brocchinia hills, in wet places on Savana Hills, and locally nearer the precipices. Another species of *Brocchinia*, besides occupying the Bromelia zone on the crest slopes of Ridge 25, formed much of the lush moist undergrowth in the Valley Headwoods, at Central Camp, and in the moist wooded parts of Savana Hills. It may thought of as occupying the bottoms of most of the valleys and depressions of the plateau. Its flowering stems are considerably higher than a man.—G. H. H. T.

centro nidulante; sepalis liberis, ovatis, acutis, carinatis, bene complanatis, membranaceis, 12 mm. longis; petalis albis (ex cl. G. H. H. Tate), quam sepala multo longioribus, laminis latis; staminibus styloque exsertis (?), ovario anguste ovoideo, supero.

Strongly caulescent, 9 cm. high; leaves crowded along the stem and stiffly spreading, 9 cm. long, sheaths submembranous, almost orbicular, blades narrowly linear, acuminate, pungent, 3 mm. wide, finely and remotely serrate, the teeth less than 0.5 mm. long and fully 2 mm. apart, glabrous above, cinereous-lepidote below; inflorescence simple, capitate, sessile at the end of the stem and obscured by the top leaves; sepals free, ovate, acute, keeled, strongly compressed, membranaceous, 12 mm. long, both the posterior overlapping the anterior; petals white (acc. to G. H. H. Tate), much longer than the sepals, their blades broad and probably spreading; stamens and styles exserted (difficult to be certain as the flowers are soft and preserve badly), ovary slenderly ovoid, superior (Fig. 3).

Crest or slope of Ridge 25, 5500–6300 ft., *404*.

The following specimen, though sterile and with somewhat narrower leaves, apparently belongs here; Agüita, slopes of Mt. Duida, 3100 ft., *936*.

Navia brachyphylla L. B. Smith, sp. nov. Caulibus 3–6 dm. longis, quaquaverse denseque foliosis; foliis rigidis; vaginis parvis, pallide brunneis, subscariosis, dissite minuteque lepidotis; laminis anguste triangularibus, 5 cm. longis, 4.5 mm. latis, viridibus, margine atro-brunneis, dense minuteque denticulatis, supra glabris, subtus minute peradpresseque lepidotis mox glabris; inflorescentia dense capituliforme, in foliorum centro nidulante, 1 cm. diametro metienti; bracteis florigeris anguste lanceolatis, acutis, 12 mm. longis, membranaceis, pallide brunneis, apice minute brunneo-lepidotis; floribus breviter crasseque pedicellatis; sepalis anguste lanceolatis, acutis, bracteis valde similibus, 10–11 mm. longis, apice minute dissiteque brunneo-lepidotis; petalis flavis, ad 18 mm. longis, basin versus in tubum connatis, lamina obovata.

Stems 3–6 dm. long; leaves densely many-ranked, rigid; their sheaths small, pale brown, sparsely fine-lepidote, subscarious; blades narrowly triangular, 5 cm. long, 4.5 mm. wide, green with a dark brown margin, densely and minutely denticulate, glabrous above, minutely appressed-lepidote below, soon becoming glabrous; inflorescence densely capituliform, immersed in the center of the terminal leaf-rosette, 1 cm. in diameter; floral bracts narrowly lanceolate, acute, 12 mm. long, membranaceous, pale brown, minutely brown-lepidote at apex; flowers with short stout pedicels; sepals narrowly lanceolate, acute, almost exactly like the floral bracts in appearance, 10–11 mm. long, sparsely and finely brown-lepidote at apex, the two lateral sepals strongly conduplicate and enclosing the nearly flat abaxial sepal; petals yellow, up to 18 mm. long, connate into a tube below, blade obovate; style and stamens included (Fig. 3).

Ridge northwest of Vegas Brook, 4400 ft., *571.*

A brief summary of the genus Navia will indicate the position of the two new species here proposed:

Inflorescence paniculate, with a distinct scape — *N. caulescens.*
Inflorescence capituliform, sunk in the center of the terminal leaf-rosette.
  Leaves 12–15 mm. broad; acaulescent: sepals 19 mm. long — *N. angustifolia.*
  Leaves not over 6 mm. broad; caulescent or acaulescent; sepals not over 12 mm. long.
    Leaf-blades entire except for a few rudimentary teeth near the base *N. Gleasonii.*
    Leaf-blades evenly spinulose-denticulate.
      Leaf-blades remotely spinulose — *N. duidae.*
      Leaf-blades densely spinulose.
        Plant aculescent or nearly so; sepals glabrous — *N. acaulis.*
        Plant long-caulescent; sepals lepidote — *N. brachyphylla.*

PITCAIRNIA NUDA Bak. The following which consist of leaves only probably belong here: crest of the Savanna Hills, 4400 ft., *857;* crest of Ridge 23½, 6000 ft., *575c.*

Tillandsia (§ ALLARDTIA) **duidae** L. B. Smith, sp. nov. Certe metralis vel ultra: foliis lingulatis, apice breviter acutis, ad 40 cm. longis, super vaginam anguste ellipticam 4 cm. latis, lepidibus minutissimis obtectis; scapo ignoto; inflorescentia laxe tripinnata, 30 cm. longa; axi leviter flexuoso, angulato, glabro; bracteis primariis ovato-acutis, patentibus, rubris, quam ramos axillares 1–2-spicatos multo brevioribus; spicis dense 6–12-floris, lineari-lanceolatis, ad 7 cm. longis, 15 mm. latis (statu florifero), vix complanatis; rachide glabra, angulata, leviter geniculata; bracteis glabris, subcoriaceis, carinatis, nervatis, ad 20 mm. longis, sepala superantibus; sepalis liberis, oblongo-lanceolatis, acutis, carinatis, nervatis, glabris; petalis quam sepala 5 mm. longioribus, laminis angustis; staminis inclusis, stylum subaequantibus.

At least a meter high: leaves ligulate, abruptly acute, 40 cm. long, 4 cm. wide above the narrowly elliptic sheath, green, minutely appressed-lepidote, appearing glabrous; scape not known; inflorescence laxly tripinnate, 30 cm. long; axis slightly flexuous, angled, glabrous; primary bracts ovate-acute, spreading, subcoriaceous, red, about half as long as the axillary branches of 1–2 spikes; spikes densely 6–12-flowered, linear-lanceolate, 7 cm. long, 15 mm. wide (before the capsules spread the bracts), scarcely compressed at all; rachis glabrous, angled, slightly geniculate; floral bracts glabrous, subcoriaceous, keeled, nerved, 20 mm. long, exceeding the sepals; sepals free, oblong-lanceolate, acute, keeled, nerved, glabrous; petals 5 mm. longer than the sepals, blade narrow; stamens included, about equaling the slender style (Fig. 3; Pl. 26).

Slopes of Ridge 25, 5500–6000 ft. *437.* It is suggestive of *T. elata* Bak. in the general form of leaves and inflorescence, but the sepals are free and the spikes are scarcely if at all compressed.

TILLANDSIA FENDLERI (Bak.) Mez. Epiphytic, crest of Ridge 25, 6300 ft., *520;* formerly known from Cuba (fide Harms), Haiti, and northern

Venezuela. The Duida specimen is stunted and not altogether typical, a result possibly of the high altitude at which it grew.

TILLANDSIA MICRANTHA Bak. Laterite Valley, Savanna Hills, 4400 ft., *782;* formerly known from Trinidad and the Island of Margarita off the coast of Venezuela.

TILLANDSIA TURNERI Bak. Summit of Peak 7, 7100 ft., *1046;* known also from Mt. Roraima in British Guiana and the Andes of Colombia. No. *608* from the same locality but consisting of leaves only probably belongs to this species also.

COMMELINACEAE

Lowland species

DICHORISANDRA HEXANDRA (Aubl.) Kuntze. Left bank of the Rio Casiquiare at Quemapure, *168;* widely distributed in tropical South America.

PONTEDERIACEAE

Lowland species

PIAROPUS CRASSIPES (Mart.) Britt. Floating at edge of the river, Esmeralda, *307;* common in quiet waters throughout the American tropics.

LILIACEAE

Lowland species

SMILAX BENTHAMIANA A. DC. Rocky top of Esmeralda Ridge, *200;* hitherto known only from the original collection by Spruce along the Rio Negro.

Species of Mount Duida

SMILAX FLORIBUNDA Kunth. Hillsides and flat ground at Central Camp, 4800 ft., sterile, *541;* a vine with immature fruit on Agüita Slope, 4000 ft., *869.* The species is also distributed through the Andes at moderate altitudes from Colombia to Peru.

TOFIELDIA SCHOMBURGKIANA Oliver. On rocks in stream-bed at Central Camp, flowers green, 4800 ft., *546;* Caño Sapo, 6300 ft., *690;* summit of Peak 7, 7100 ft., *655;* previously known only from high altitudes on Mount Roraima.

VELLOZIACEAE

Species of Mount Duida

BARBACENIA ALEXANDRINAE Schomb. Dry ridge tops, Savanna Hills, 4400 ft., *801.* Schomburgk is apparently the only botanist who has hitherto observed this remarkable plant in the field. Sterile plants were found by him on the Humirida Mountains, just south of Roraima, and fertile plants

were collected later near the source of the Caroni. It probably occurs in isolated patches in suitable habitats throughout this sandstone range of mountains.[1]

DIOSCOREACEAE

Lowland species

DIOSCOREA MEGACARPA Gleason. Santa Isabel, on the Rio Negro, northern Brazil, *1053;* also known from the Guianas and the northern Amazon region.

MUSACEAE

Species of Mount Duida

HELICONIA GLAUCA Poit. Slopes of the mountain at Agüita, 3100 ft., *900.* The species is distributed from northern Brazil to the Caribbean Sea.

ZINGIBERACEAE

Lowland species

COSTUS CYLINDRICUS Jacq. In forest, Santa Isabel, northern Brazil, *79;* perhaps the commonest species of the genus, widely distributed through tropical South America and the West Indies.

RENEALMIA (?) EXALTATA L. f. Preguisa, on the Rio Negro, northern Brazil, *144.*

RENEALMIA FLORIBUNDA K. Schum. Caxoeira San Sebastian, on the Rio Casiquiare, Venezuela, *152.* The two specimens of this genus are both without leaves and can not be identified satisfactorily.

CANNACEAE

Lowland species

CANNA COCCINEA Mill. Buena Vista, on the Rio Casiquiare, Venezuela, *155.* This is the commonest species of *Canna* in northern South America and ranges from Bolivia to the West Indies.

MARANTACEAE

Lowland species

ISCHNOSIPHON LEUCOPHAEUS (Poepp. & Endl.) Koern. Mouth of the Casiquiare Canal on the Colombian side, *1003;* New Savanna at Esmeralda, *952;* known only from this general region.

[1] The only specimens seen of this oddly branching plant were growing at Savana Hills. On the crest of the ridge, plants were scattered sparsely among the bushes or in the open. Strangely a few flood-torn specimens were also noted in the rocks in the bed of the Caño Negro. The largest individuals observed were about six feet high.—G. H. H. T.

BURMANNIACEAE

Lowland species

BURMANNIA BICOLOR Mart. East Swamp at Esmeralda, *264;* distributed from Brazil to the West Indies.

Burmannia bracteosa Gleason, sp. nov. *B. capitatae* affinis: foliis basalibus nullis, caulinis anguste ovatis; caulibus gracilibus cymis dichotomis multifloris; bracteis oblongis patulis vel recurvatis; floribus confertis secundis brevissime pedicellatis; ovario et corollae tubo triangulare non alato, lobis erectis triangularibus marginibus inflexis conniventibus; filamentis brevissimis reflexis.

Stems very slender, leafless below, 15–25 cm. tall, with about four narrowly ovate appressed scales 2–3 mm. long, the upper one of which occasionally subtends a much reduced flowering branch; cyme bifurcate, its branches straight, ascending, 10–15 mm. long, bearing as many as 13 flowers; flowers sessile, crowded, strictly secund, bracteate; bracts narrowly oblong, 2 mm. long, 0.8 mm. wide, sharply acute, strongly folded down the midvein, borne on the upper side of the rachis and conspicuously spreading or recurved to the outside; ovary at anthesis 2.3 mm. long, obpyramidal, sharply 3-angled; 3-celled with axile placentae; perianth-tube triangular, not winged or expanded above, 2.7 mm. long; perianth-lobes 3, broadly ovate, 0.8 mm. long, erect, sharply acute, the margins inflexed above and connivent to form a cucullate tip; filaments very short, reflexed, with the acuminate connective 0.6 mm. long; anthers 0.6 mm. wide, of which the triangular-ovoid thecae and the transverse connective each measure 0.2 mm. (Pl. 24, fig. 2).

Growing in the East Swamp at Esmeralda, *268*, in part. It is closely related to *B. capitata* (Walt.) Mart., the two being the only species with wingless perianth and erect or connivent perianth-lobes. Our species is characterized by its longer inflorescence, its conspicuous spreading bracts, and its sessile flowers.

BURMANNIA CAPITATA (Walt.) Mart. East Swamp at Esmeralda, *268*, in part; a widely distributed species, extending from the southern United States to Brazil (Pl. 24, fig. 2).

Species of Mount Duida

Burmannia foliosa Gleason, sp. nov. Caule erecto simplice ad dimidium folioso superne bracteoso; foliis late linearibus caulem vaginantibus; bracteis adpressis; floribus in racema capituliforme dense aggregatis breviter pedicellatis; bracteis obovato-oblongis quam floribus brevioribus; hypanthio obconico triquetro, angulo infero subalato; perigonii tubo non ampliato, segmentis exterioribus late ovatis ad anthesin irregulariter bilobis quam interioribus dupla vel ultra longioribus, interioribus quadrato-obovatis truncatis margine dense pubescentibus; staminibus sessilibus, connectivo apice rotundato basi breviter prolongato truncato, thecis reniformibus; stigmatibus 3 ovoideis divaricatis.

Stems herbaceous, simple, erect, 1–3 dm. high, densely leafy on the basal third or half, bracteate above; leaves sessile, broadly linear, 3–6 cm. long, 6–8 mm. wide, strongly sheathing and appressed at the amplexicaul base, spreading above, acute and glandular-callous at the apex, 5–7-nerved; bracts appressed, lanceolate, amplexicaul, 1–2 cm. long, acuminate to the glandular tip, much shorter than the internodes; flowers numerous, closely aggregated in a dense head-like raceme 1 cm. in diameter, apparently blue; bracts very thin, sessile, obovate-oblong, 5 mm. long, 2 mm. wide, obtuse or subacute and minutely erose near the summit, obscurely 1–3-nerved; pedicels 3-angled, nearly 2 mm. long; hypanthium obpyramidal, 3-angled, the lower angle subalate, 2.5 mm. long; perianth-tube not expanded, 1.5 mm. long; sepals broadly ovate, 1.3 mm. long and wide, obtuse, the tip shallowly 2-lobed at anthesis; petals quadrate-obovate, truncate, 0.5 mm. long and wide, minutely pubescent on the margin, the central portion convex toward the inside, their margins continued laterally at the base into a membrane adnate to the sepals, forming 6 minute sacs; stamens 3, sessile; connective ellipsoid. 0.5 mm. long, rounded above, truncate below; thecae lateral, reniform; style stout, 1.5 mm. long; stigmas 3, fleshy, rounded, and spreading; ovary inferior, 3-celled; ovules very numerous, on axial placentae.

Summit of Peak 7, 7100 ft., *630* (type); at Caño Sapo, 6200 ft., *598*. This new *Burmannia*, remarkable for its leafy stems, is related to *B. Kalbreyeri* Oliver and *B. polygaloides* Schltr., which are similarly leafy. The former, from Colombia, is differentiated by its much longer leaves, loose open racems, acute sepals, and minute linear-lanceolate petals. The latter resembles ours in its inflorescence and obtuse petals, but has much smaller and narrower leaves, linear-lanceolate bracts, and acuminate sepals.

(*Continued in the June issue*)

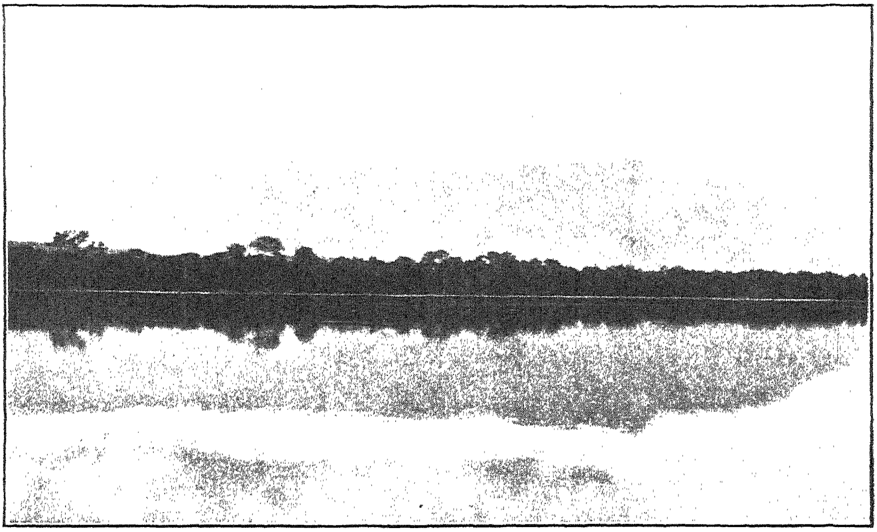


FIG. 1. MOUNT DUIDA, FROM THE ORINOCO RIVER AT ESMERALDA

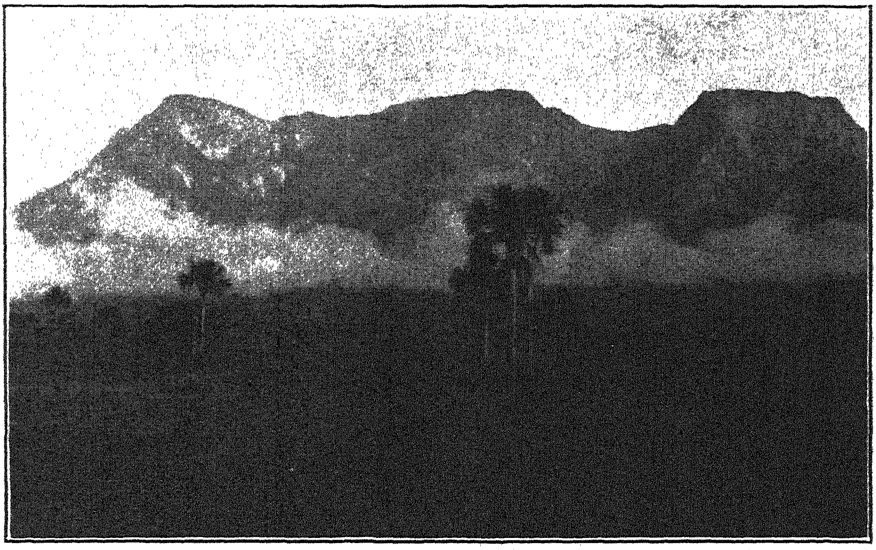


FIG. 2. SOUTHERN END OF MOUNT DUIDA. FROM LEFT TO RIGHT: PEAKS 7, 15, AND 21-22

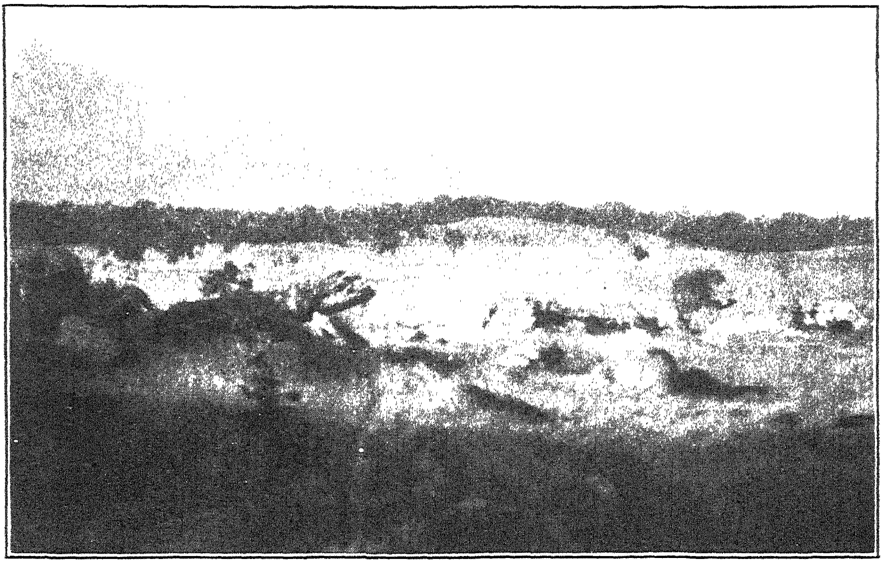


FIG. 1. ESMERALDA SAVANNA AND MOUNT DUIDA. MOUNT MARAHUACA IS BARELY VISIBLE IN THE RIGHT BACKGROUND

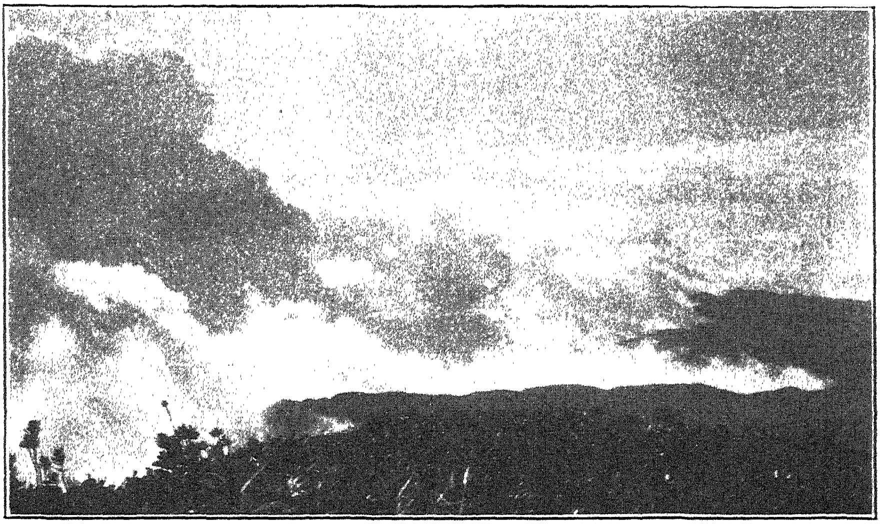


FIG. 2. EDGE OF THE CLIFFS AT PEAK 7, SUMMIT OF MOUNT DUIDA

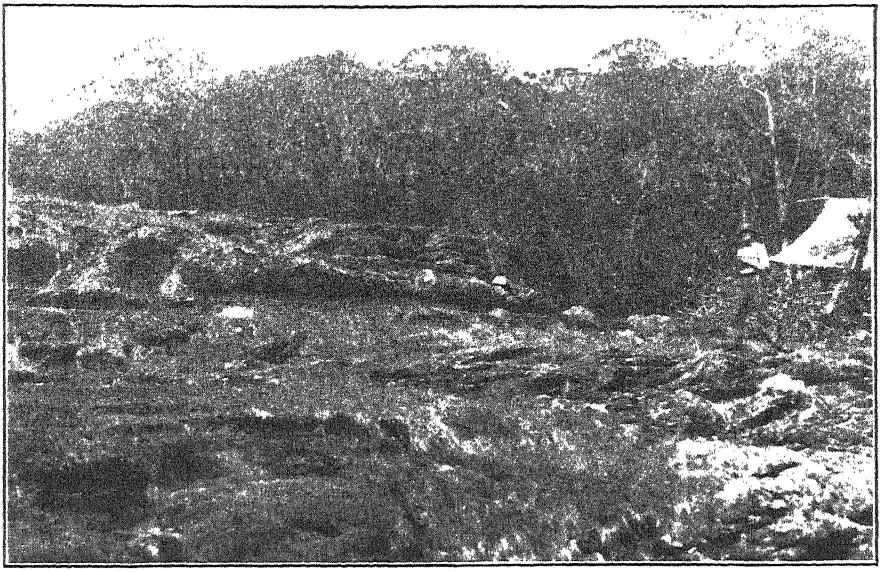


FIG. 1. STREAM-BED ABOVE VEGAS FALLS, SUMMIT OF MOUNT DUIDA

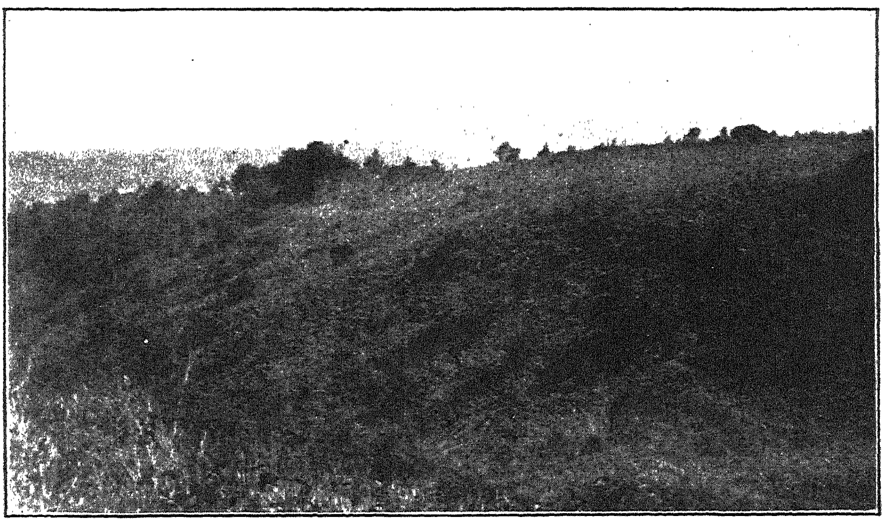


FIG. 2 VIEW TO THE EAST ACROSS THE SAVANNA HILLS, SUMMIT OF MOUNT DUIDA, TO MOUNT MARAHUACA IN THE DISTANCE

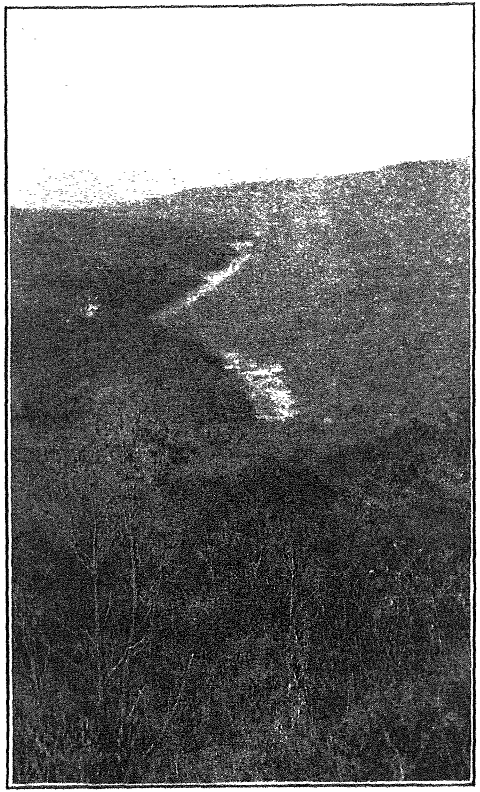


FIG. 1 CANO NEGRO, NEAR CENTER OF THE PLATEAU, SUMMIT OF MOUNT DUIDA

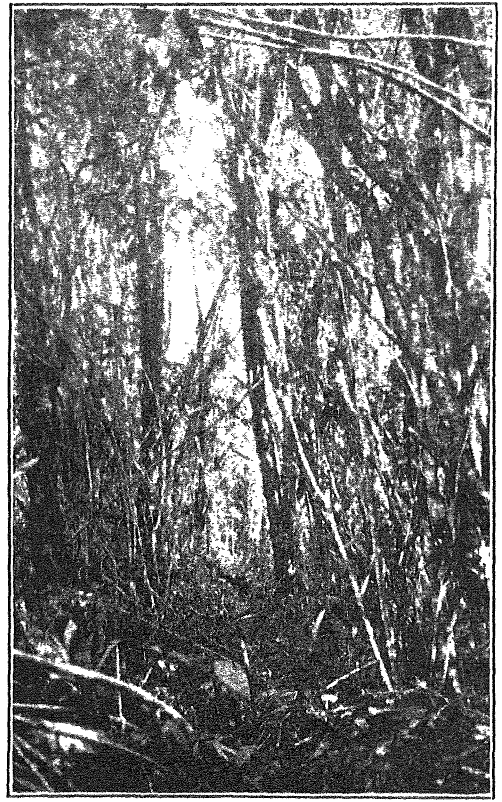


FIG. 2. TRAIL THROUGH A MORE OPEN PART OF THE FOREST, SUMMIT OF MOUNT DUIDA

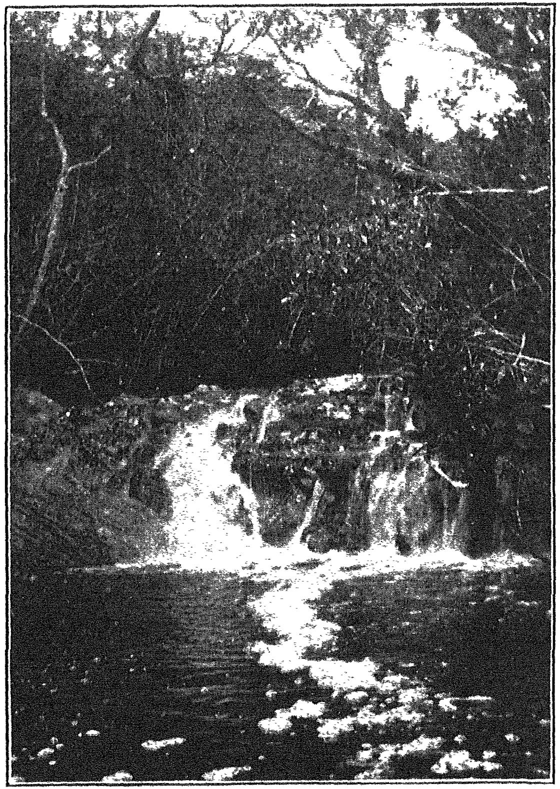


FIG. 1. WATERFALL NEAR CENTRAL CAMP, SUMMIT OF MOUNT DUIDA

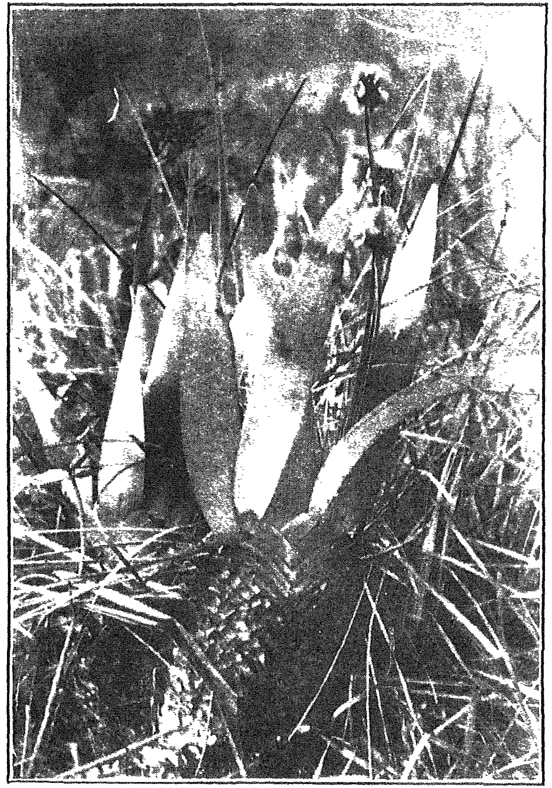
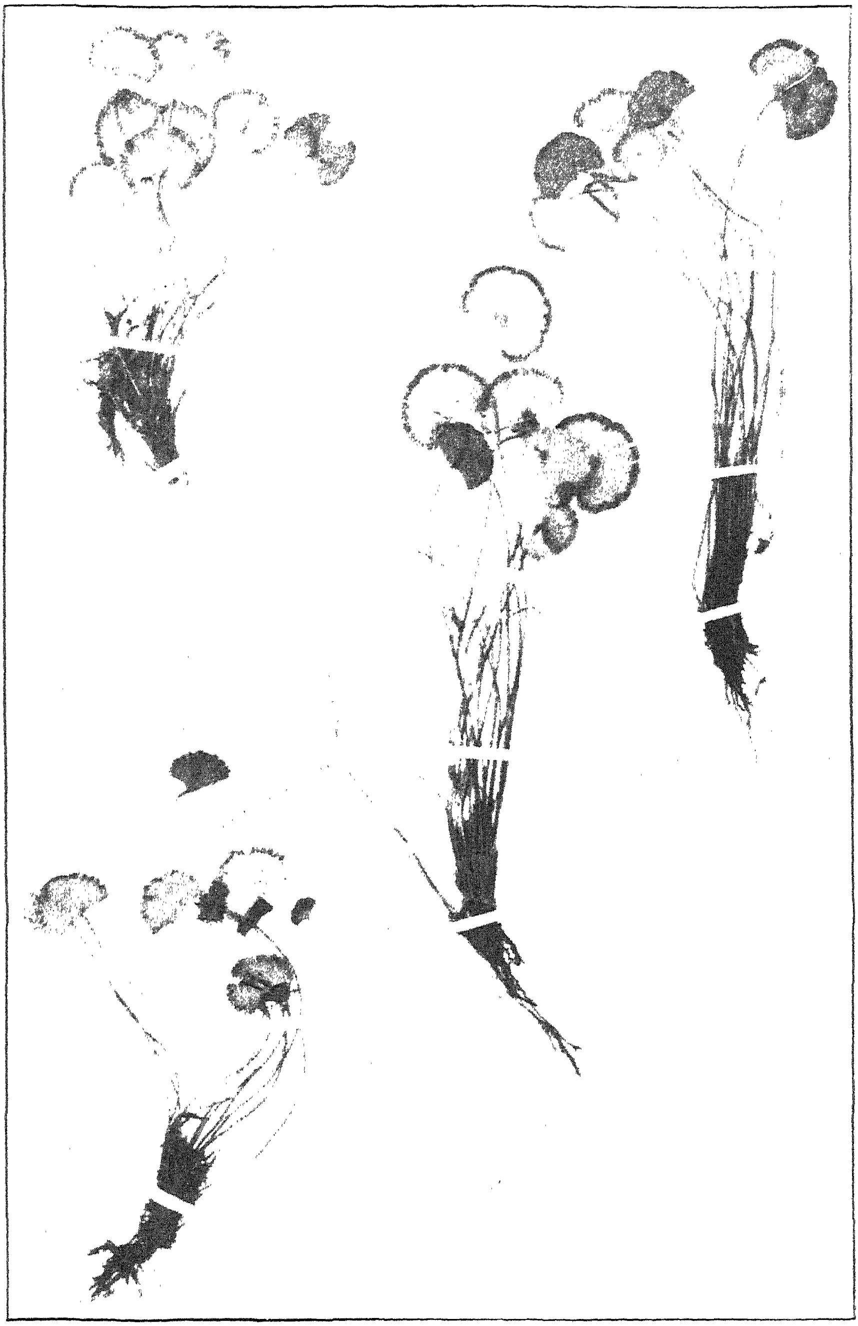


FIG 2 STEGOLEPIS PUNGENS

HYMENOPHYLLOPSIS ASPLENIOIDES × 3/4



PTEROZONIUM TATEI × 1/2

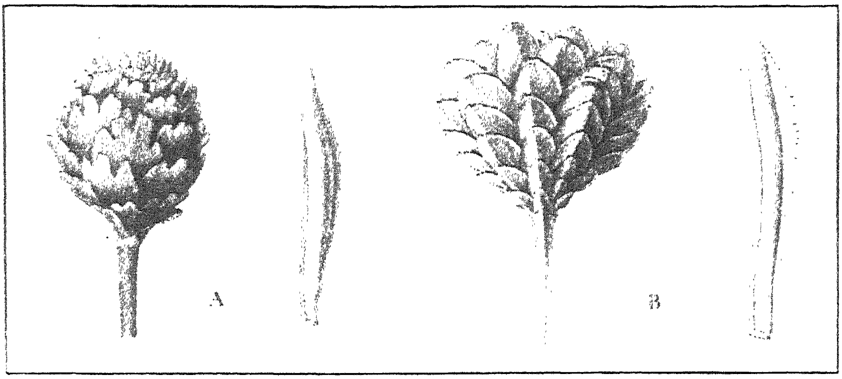


FIG. 1. A. XYRIS LUGUBRIS. SPIKE × 2. LATERAL SEPAL × 6.
B. XYRIS TATEI. SPIKE × 2. LATERAL SEPAL × 6

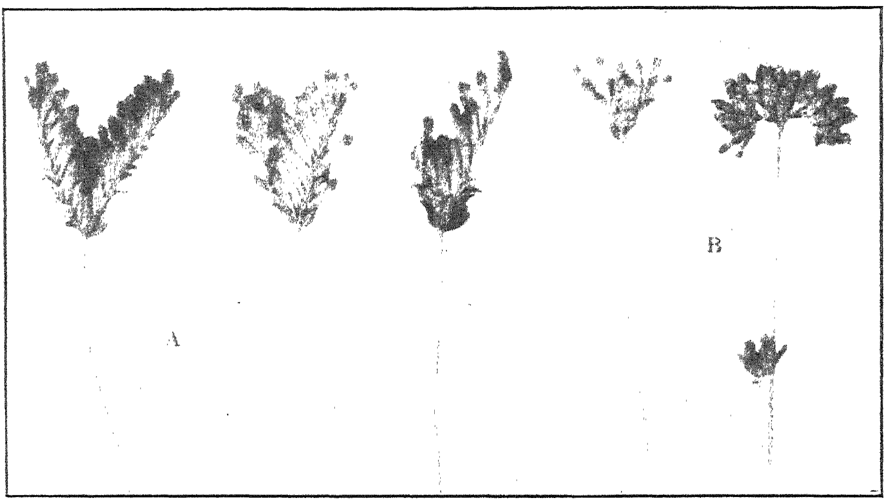
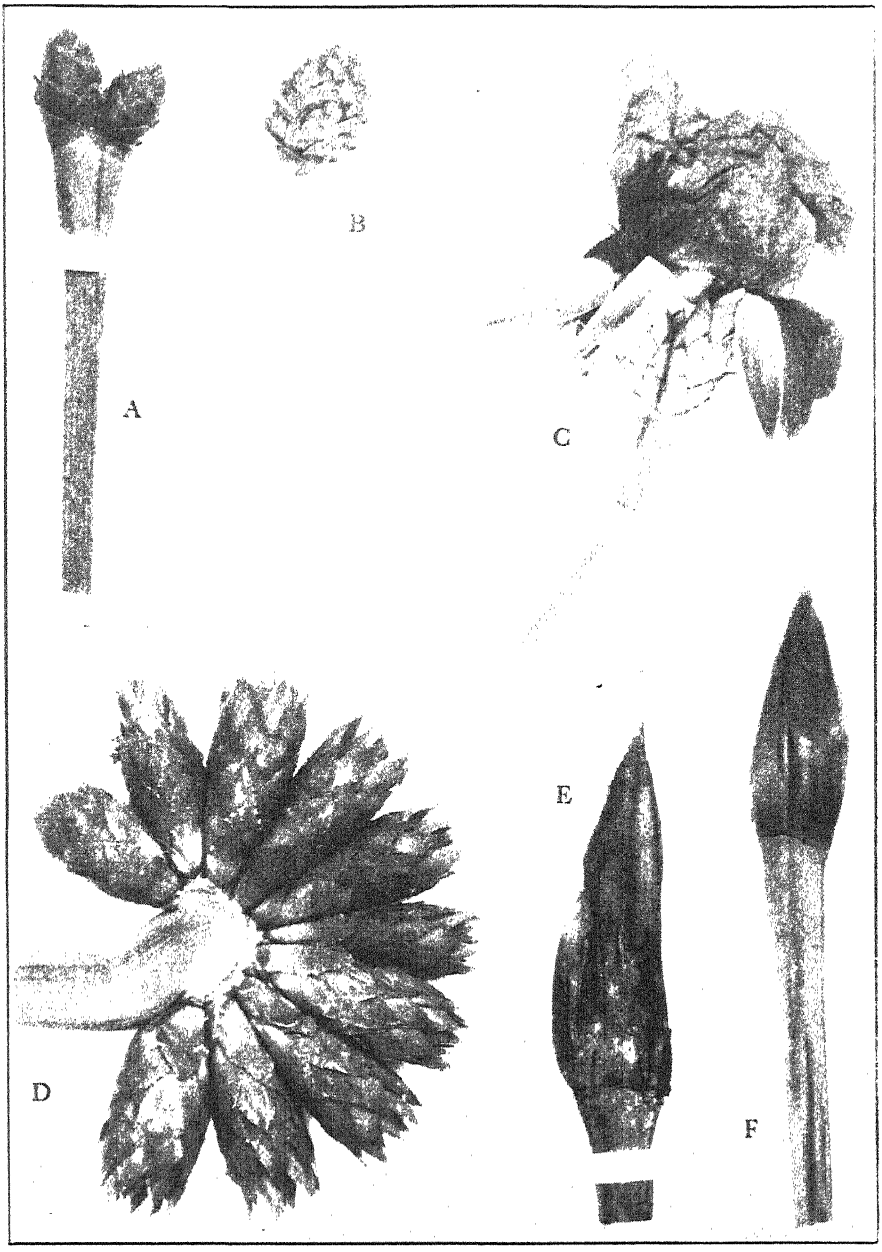
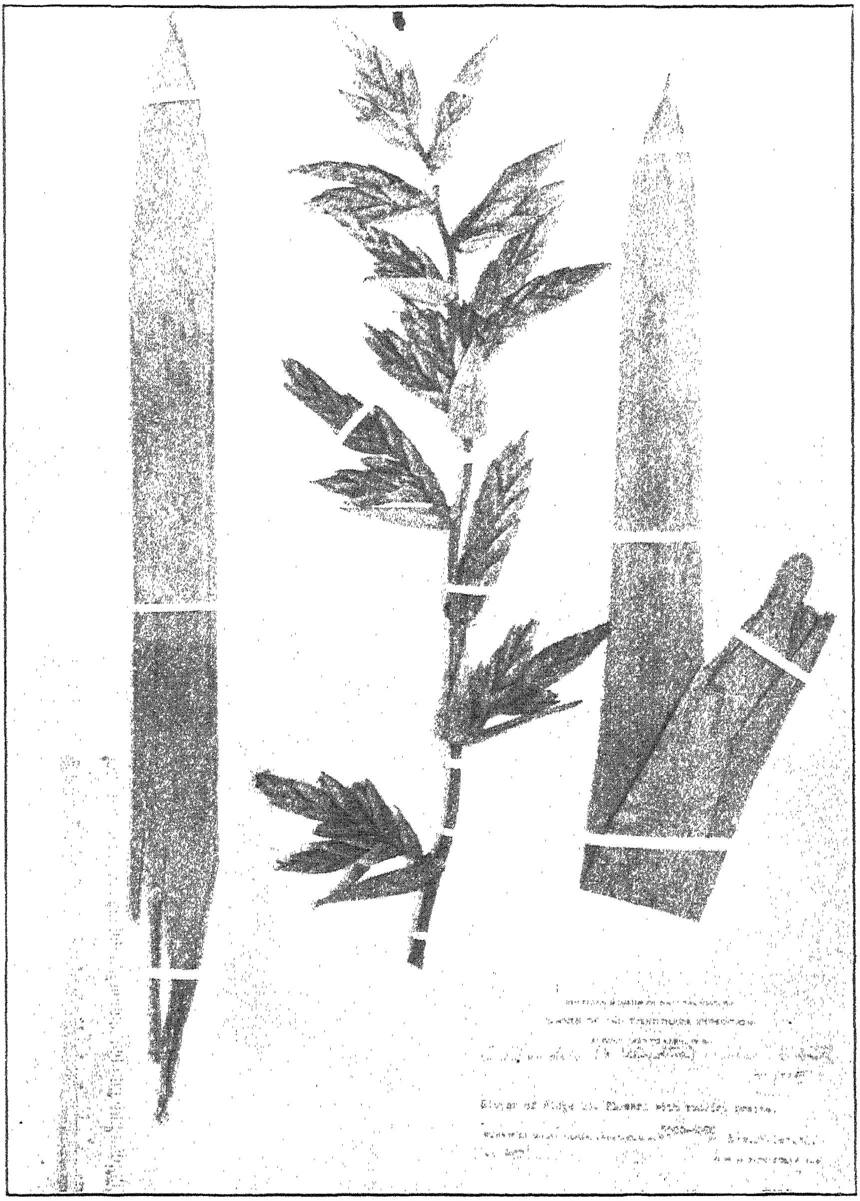


FIG. 2. A. BURMANNIA BRACTEOSA × 5/3. B. BURMANNIA CAPITATA × 5/3



A. STEGOLEPIS LINEARIS. B. MONOTREMA XYRIDOIDES. C. STEGOLEPIS PAUCIFLORA. D. STEGOLEPIS PUNGENS. E. F. AMPHIPHYLLUM RIGIDUM. ALL ENLARGED ONE FOURTH



TILLANDSIA DUIDAE $\times$ 3/8

Botanical results of the Tyler-Duida Expedition

H. A. Gleason

(Continued from the May issue)

ORCHIDACEAE[1]

Lowland species

Genus? Swampy ground, Grand Savanna, Esmeralda, *293*, flowers yellow. This collection represents what appears to be a new genus allied to the *Pogonieae*, but only the powdery remnants of the pollinia are present, so the erection of a new concept is impossible.

Epistephium parviflorum Lindl. New Savanna, Esmeralda, *954*, terrestrial, 4 ft. high, flowers pink and purple; Tree Savannas, Esmeralda, *320*, terrestrial, 3 ft. tall, flowers purple. The poor flowers make this last determination only probable. The species extends from the island of Trinidad to British Guiana and Brazil.

Sobralia liliastrum Lindl. On Esmeralda Ridge, among rocks, *183*, *187*, flowers white with yellow lip; widespread in British Guiana and Brazil.

Epidendrum variegatum Hook. Middle Camp, Esmeralda, *958*, epiphytic, flowers small, yellowish white, spotted with brown. A widespread species extending from the West Indies, Costa Rica, and Panama through northern South America to Ecuador, Peru, and Brazil.

Cattleya violacea *Rolfe. Fish Creek, Esmeralda, 961. This species* extends from Venezuela through British Guiana to Peru and Brazil.

Brassavola sp. (sterile) Epiphytic on trees, Camanaos, Rio Negro, northern Brazil, *118*.

Species of Mount Duida

Genus? Moist slopes of Savanna Hills, 4400 ft., *736*. This collection seems to belong to the same unknown genus as was cited in the list of the lowland orchids, and is not defined for similar reasons. It is apparently a second species of this genus and is markedly larger throughout than the lowland plant.

Epistephium sp. (immature buds) Moist slopes of Savanna Hills, 4400 ft., *749;* stem 4 ft. high, leaves shining, flowers pink.

Elleanthus sp. (flowers poor) Crest of Ridge 25, 6300 ft., *455;* slender, scandent, leaves grass-like, flowers small, pink. The branching habit of this species recalls the Costa Rican *E. Tonduzii* Schltr.

[1] By Oakes Ames and Charles Schweinfurth.

[The Bulletin for May (58: 277–344) was issued 21 November 1931.]

ELLEANTHUS sp. (sterile) Central Camp, 4800 ft., *581*. The plant has a strongly fractiflex rachis and appears altogether similar to the Central American *E. laxus* Schltr.

SOBRALIA sp. (sterile) Camp Woods, Savanna Hills, 4400 ft., *841;* terrestrial, 5 ft. high.

SOBRALIA sp. ? (sterile) Camp Woods, Savanna Hills, 4400 ft., *842,* epiphytic and terrestrial.

STELIS sp. (sterile) Flat near stream at Central Camp, 4800 ft., *545;* on tree trunk. A little plant recalling the Central American *S. parvula* Lindl.

STELIS sp. Laterite Valley, Savanna Hills, 4400 ft., *838;* flowers yellow. Apparently this species is allied to *S. argentata* Lindl., but is smaller throughout, and has yellow, instead of green and rose flowers. The flowers are insufficient for diagnostic purposes.

PLEUROTHALLIS sp. ? (sterile) Camp Woods, Savanna Hills, 4400 ft., *848*. This collection may represent a *Restrepia*.

PLEUROTHALLIS sp., probably (sterile). Camp Woods, Savanna Hills, 4400 ft., *1051*.

PLEUROTHALLIS sp. ? (sterile) Laterite Valley, Savanna Hills, 4400 ft., *764*. This species may be referable to *Stelis* or *Physosiphon*. It resembles some forms of *Pleurothallis velaticaulis* Reichb. f.

PLEUROTHALLIS sp., aff. *P. hamosa* Barb. Rodr. Epiphytic in woods, Savanna Hills, 4400 ft., *823*. The single flower found is old and imperfect.

PLEUROTHALLIS sp. or LEPANTHES sp. (sterile) Camp Woods, Savanna Hills, 4400 ft., *851;* epiphytic. This collection probably represents a *Pleurothallis*, section *Lepanthiformes*.

PLEUROTHALLIS RORAIMENSIS Rolfe. On tree trunks, slopes of Ridge 25, 4500–6000 ft., *446;* Central Camp, 4800 ft., *1021*. This minute plant appears to be recorded only from Mount Roraima.

PLEUROTHALLIS STENOCARDIUM Schltr. Desfiladero, 6000 ft., *717;* epiphytic, leaf tinted red. A near ally of this plant is the Guatemalan *P. pansamalae* Schltr. The species has been recorded only from Mount Roraima.

PLEUROTHALLIS UNILATERALIS Cogn. Epiphytic in woods, Savanna Hills, 4400 ft., *825*. Heretofore the range of this Lepanthiform *Pleurothallis* was limited to Brazil.

Lepanthes duidensis A. &. S., sp. nov. Herba minuta, caespitosa. Caules filiformes, paucivaginati vaginis inconspicue scabridis. Folium singulum, erectum, ovatum, acutum, marginatum. Inflorescentiae singulae vel duae, quam folium multo breviores, pauciflorae. Flores parvi, in sicco membranacei. Sepala ovata, glabra, uninervia, lateralia obliqua. Petala transverse oblonga, lateribus

rotundatis. Labellum obscure trilobatum, lobis lateralibus conspicuis et columnam multo superantibus, lobo intermedio minutissimo.

Epiphytic, very small, caespitose, up to 3.2 cm. high to the tip of the erect leaf. Roots fibrous, filiform, flexuous. Stems filiform, when mature up to 2 cm. long, closely invested by 4 to 6 tubular sheaths which are minutely scabrous on the longitudinal ribs and have ovate spreading ciliate mouths. Leaf elliptic-ovate to broadly ovate, 7.5–13.5 mm. long, 5–9 mm. wide, acute or minutely tridenticulate at the apex, cuneate or (in the dried condition) more generally rounded at the shortly petioled base, margined. Inflorescences very short, apparently 2–4-flowered. Flowers small, perianth spreading. Sepals ovate, acute, 1-nerved. Dorsal sepal 2.2 mm. long. Lateral sepals oblique, obtusely acute, connate shortly above the base, 1.9 mm. long. Petals transversely cuneate-oblong, apex shallowly retuse and apiculate, 0.9 mm. long, about 2 mm. wide, lobes broadly rounded with the posterior lobe somewhat larger, disc minutely pubescent. Labellum 3-lobed; lateral lobes narrowly and very obliquely dolabriform, with a longitudinal keel parallel to the outer edge, pubescent, about 1 mm. wide along the outer margin; middle lobe minute, round-ovate, concave, pilose on the under surface. Column markedly shorter than the lateral lobes of the labellum.

Epiphytic in woods, Savanna Hills, 4400 ft., *824* (duplicate type in Herbarium of Oakes Ames no. *35345*); flowers red or white.

Lepanthes duidensis has three rather close allies in Colombia. It is apparently nearest to *L. Schnitteri* Schltr., but differs in having broader leaves which are rounded at base in the dried specimen, broader petals, and relatively shorter column. While outwardly very similar to *L. marginata* Schltr., it varies in having smooth-margined 1-nerved sepals and a dissimilar lip. It is distinct from *L. Wageneri* Reichb. f., another of its allies, in its broadly ovate, not orbicular, leaves which are green on both sides, in having flowers of a different color, and in the dissimilar petals.

OCTOMERIA sp., probably (sterile). Camp Woods, Savanna Hills, 4400 ft., *847;* epiphytic.

OCTOMERIA sp., probably (sterile and fruiting). Caño Sapo, 6300 ft., *689;* epiphytic.

OCTOMERIA sp., probably. Near summit of Peak 7, 7050 ft., *670;* epiphytic, flowers dull pinkish or rose. This plant lacks the diagnostic pollinia, but is most probably a representative of this genus. It is remarkable, however, in having several of its stems terminated by two subopposite leaves. It is perhaps most nearly related to *O. tridentata* Lindl. and *O. colombiana* Schltr., but with very dissimilar lip.

OCTOMERIA sp., probably. Flat near stream at Central Camp, 4800 ft., *543;* epiphytic on tree-trunk. This plant is undoubtedly conspecific with the foregoing plant, no. *670*, judging by the appearance and floral struc-

ture. In general it represents a more advanced stage of development, but the one bud present showed only six pollinia!

OCTOMERIA sp., probably. Slopes and flats at Central Camp, 4800 ft., *554;* on tree-trunks. All the plants of this very small species have well developed ovaries. In the flowers examined the pollinia were missing. However, this collection doubtless represents an *Octomeria* of the section *Teretifoliae.*

Brachionidium longicaudatum A. &. S., sp. nov. Herba pusilla, epiphytica. Radices crassae. Rhizoma prorepens, vaginis tubulatis caudatis dense vestitum. Caules minuti, monophylli. Folium ellipticum, apiculatum, subtus rubrum. Pedunculi singuli, folia superantes, filiformes. Flos parvus. Perianthii segmenta ovata cum longis caudis, in medio ciliolata. Labellum valde sigmoideum, parte inferiore convexa pubescente, parte apicale triangulare, acuta, concava. Gynostemium crassum.

Plant very small but with stout glabrous roots. Rhizome creeping, concealed by approximate or imbricating tubular sheaths with conspicuous spreading long-acuminate or caudate apices. Stems minute, monophyllous, entirely concealed by 2 imbricating tubular sheaths with abruptly long-acuminate or caudate tips. Leaf elliptic, spreading, 7.5–11.5 mm. long, about 3.5–4 mm. wide, rigid, apiculate, coriaceous, very shortly petioled. Peduncle solitary 1-flowered, much exceeding the leaf, 1.5–1.6 cm. long, filiform, provided above the middle with a single loose tubular abruptly caudate sheath. Ovary clothed at base with a similar infundibuliform sheath. Flower small. Perianth-segments caudate, ciliolate in the middle of each side. Dorsal sepal ovate with long caudate apex, 9.5–9.8 mm. long, 3–3.4 mm. wide near the base, 3-nerved. Lateral sepals connate nearly to the apex, lamina very similar to the dorsal sepal but a little broader, 3.2–4 mm. wide, 5-nerved with 2 long prominent nerves. Petals lanceolate-ovate with long caudate apex, 8.2–8.7 mm. long, about 2 mm. wide, slightly oblique. Labellum minute, closely sigmoid in natural position, entire and lanceolate-oblong when forcibly spread out; basal portion quadrate, convex, pubescent, 3-nerved, terminating in a fleshy transverse obscurely bilobed callus; terminal third concave with triangular acute upturned apex, lower margins fleshy-thickened. Column stout with dentiform erect arms.

Valley between Peaks 7 and 16, 6500 ft., *682;* small, epiphytic, capsules red, leaves red beneath. *Brachionidium longicaudatum* is apparently most nearly allied to *B. parvum* Cogn. but differs in its distinctive lip. The description is drawn from a small specimen with flowers in an advanced state of development. The specific name is in allusion to the sheaths, bracts, sepals, and petals.

SCAPHYGLOTTIS sp. ? (sterile) Epiphytic in woods, Savanna Hills, 4400

ft., *832.* This collection has a somewhat similar aspect to *Scaphyglottis grandiflora* A. & S., but has much longer stems.

Scaphyglottis grandiflora A. &. S., sp. nov. Herba patula, caespitosa ut videtur. Caules superpositi, cylindracei, in sicco tenues, in apice bifoliati, parte inferiore vaginis binis foliigeris arcte inclusa. Folia linearia, sessilia, in apice oblique bilobata. Inflorescentiae perbreves, axillares. Flos pro genere magnus. Sepalum dorsale ellipticum vel elliptico-lanceolatum. Sepalia lateralia lanceolata vel ovato-lanceolata, mentum conspicuum formantia. Petala oblique elliptico-lanceolata. Labellum in positu naturale arcuato-reflexum, e basi cuneata obovato-oblongum, in apice late rotundatum vel leviter bilobatum. Gynostemium prope apicem bialatum.

Plant spreading, caespitose, 19 cm. or more tall. Roots fibrous, flexuous, glabrous, branching, commonly springing from each mature node. Stems superposed, slender, cylindric, striate-plurisulcate in the dried specimen, diphyllous at the apex, the lower part closely enveloped by 2 tubular imbricating leaf-sheaths, sometimes as many as 9 stems issuing from a single node. Leaves linear, spreading, up to 14.2 cm. long and 5 mm. wide, obliquely bilobed and apiculate at the tip, sessile, the mid-nerve sulcate above and carinate beneath in the dried specimen. Inflorescence apparently 1-flowered, the pedicellate ovary issuing from several scarious imbricated lanceolate bracts. Dorsal sepal elliptic to elliptic-lanceolate, 9.6–13.9 mm. long, 4.2 mm. wide, acute or obtuse at the more or less cucullate apex, prominently 5-nerved, often with shorter supplementary nerves. Lateral sepals lanceolate to ovate-lanceolate, oblique, otherwise closely similar to the dorsal sepal. Petals oblong-lanceolate, to elliptic-lanceolate, oblique, 10–13.1 mm. long, 3.1–3.5 mm. wide, acute, with 3 conspicuous nerves. Labellum arcuate-reflexed in natural position, when forcibly extended obovate-oblong with a thickened cuneate base, 1.28–1.6 cm. long, 7.2–7.7 mm. wide across the slightly broader apical portion, very broadly rounded or shallowly bilobed at the apex, the margins undulate and minutely crenulate; disc fleshy-thickened through the center, the thickening diminishing toward the apex. Column slightly arcuate, 7.2 to nearly 9 mm. tall at the back, provided near the apex with a pair of round-triangular wings; foot short, dilated, forming with the sepals a conspicuous mentum. Pollinia 4, complanate-semiorbicular.

Agüita, 3800 ft., *923* (duplicate type in Herbarium of Oakes Ames no. *35347*). *Scaphyglottis grandiflora* is related to *S. violacea* Lindl., but has larger flowers, dissimilar lip, and round-auricled column.

Hexisea bidentata Lindl. On rocks, crest of First Ridge, 4500 ft., *864;* flowers flame-colored. The range of this species, as formerly known, extends from Nicaragua (*fide* R. Schlechter), Costa Rica and Panama to Colombia.

Jacquiniella globosa (Jacq.) Schltr. Epiphytic at Agüita, 3100 ft.,

939. This widespread little plant extends from Mexico, Guatemala and Nicaragua (*fide* R. Schlechter), Costa Rica, and the West Indies to Mount Roraima and Brazil.

EPIDENDRUM sp. Laterite Valley, Savanna Hills, 4400 ft., *840*. This very small plant is allied to *E. goniorhachis* Schltr., but has a single flower too old for diagnosis.

EPIDENDRUM CARNOSUM Lindl. Crest of Ridge 25, 6300 ft., *471*, the entire plant yellow-green, stems 4 ft. tall, erect; moist slopes of Savanna Hills, 4400 ft., *735;* summit of Peak 7, 7100 ft., *636*. This variable species occurs widely in Brazil but appears to be unrecorded elsewhere.

EPIDENDRUM IMTHURNII Ridl. Near summit of Peak 7, 7050 ft., *667*, terrestrial, flowers small, greenish yellow. Formerly this plant was recorded only from Mount Roraima.

Epidendrum inconstans Ames, nom. nov. *Epidendrum Lindenii* Lindl. Bot. Reg. **31,** Misc. 48, no. 59. 1845. Not *Epidendrum Lindenii* Lindl. Ann. Mag. Nat. Hist. **12**: 397. 1843.

Crest of Ridge 25, 6300 ft., *472*, stems erect, 3 ft. tall, flowers delicate, pink; same locality, *473*, *1027;* summit of Peak 7, 7100 ft., *646*, *652*. The specific name *Lindenii* was first used for a plant which was subsequently described by Lindley as *Epidendrum fallax* (Cf. Orch. Linden. 9. 1846). Therefore a new name is needed for the more recently described *E. Lindenii*. So we propose the name *E. inconstans* to represent this variable plant, which is widely distributed in Venezuela, Colombia, and Brazil, and has been credited to Ecuador and Peru.

EPIDENDRUM RAMOSUM Jacq. Epiphytic in woods, Savanna Hills, 4400 ft., *829*, flowers yellow. A very widespread species, extending from Mexico, Central America, and the West Indies through northern South America to Brazil and Peru.

Eriopsis grandibulbosa A. &. S., sp. nov. Herba robusta. Radices validae, flexuosae. Pseudobulbus pro genere longissimus, cylindraceus, prope apicem trifoliatus. Folia elliptica vel lanceolato-oblonga, acuta, inferne sensim angustata, coriacea. Scapus elatus, validus, folia subtriplo superans. Racemus longus, multiflorus. Sepalum dorsale oblongo-ellipticum. Sepala lateralia ovato-elliptica. Petala oblonga. Labellum profunde trilobatum; lobi laterales involuto-erecti, semiorbiculares; lobus intermedius spathulatus, apice truncatus; discus callis dentatis ornatus. Columna gracilis, aptera.

Plant very stout and tall even for the genus. Roots stout, fibrous, long, 3–5 mm. thick, simple or very slightly branched. Pseudobulb elongate, about 32.7 cm. long, cylindric, trifoliate near the apex, somewhat stouter at base, coarsely sulcate in the dried specimen. Leaves narrowly elliptic to lanceolate-oblong, 29.5–45.3 cm. long, 2.9–6.1 cm. wide, acute, gradually narrowed below

to the sessile base, coriaceous, many-nerved with 3 to 5 nerves conspicuous beneath, apparently shining in the fresh specimen. Scape stout and very tall, about 115 cm. long, 7 mm. thick near the base, rising strictly from the base of the pseudobulb; the naked peduncle adorned with several remote triangular to ovate acute or obtuse membranaceous sheaths. Raceme about 61.5 cm. long, rather loosely many-flowered. Perianth parts spreading. Dorsal sepal oblong-elliptic, 1.9 cm. long, 9 mm. wide, rounded at the tip with a dorsal mucro, 7-nerved below, slightly concave. Lateral sepals similar, elliptic-ovate, rounded at the tip with an acute subapical mucro, 1.82 cm. long, 1 cm. wide, concave, 6–7-nerved. Petals oblong, 1.7–1.74 cm. long, 6–6.9 mm. wide across the slightly broader basal portion, rounded at the tip with a blunt mucro, 7–8-nerved below. Labellum deeply 3-lobed, with the lateral lobes erect and tubular-involute in natural position, from the column-foot slightly exceeding the lateral sepals, 1.6–1.62 cm. long, about 1.76 cm. wide across the lateral lobes when spread out; lateral lobes obliquely semiorbicular with a broadly truncate slightly subcordate base; terminal lobe spatulate, rather fleshy, about 7.7 mm. long, nearly 9 mm. wide across the subconduplicate apical portion when expanded, apex subtruncate and shallowly retuse. Disc provided at base with a fleshy bipartite callus of which the truncate apex is 2- or 3-dentate on each side, a shorter sharper and conspicuous tooth extending to the base on each side of the sulcate center of the lip; a pair of small fleshy teeth rise just in front of this large basal callus. Column arcuate, about 9.3 mm. long, slender, complanate on the anterior face, dilated at base with a short fleshy foot. Pollinia 2, obliquely ovoid.

Valley between Peaks 7 and 15, 6500 ft., *681* (type) (duplicate in Herbarium of Oakes Ames no. *35346*), flowers dull brown with yellow lip; summit of Peak 7, 7100 ft., *653*. *Eriopsis grandibulbosa* differs from all its allies by its elongate pseudobulb and scape. It is further unlike *E. biloba* Lindl. and *E. rutidobulbon* Hook. in the spatulate or clawed terminal lobe of the lip. It differs florally from *E. Fuerstenbergii* Kränzl. in having obtuse sepals, and from *E. colombiana* Schltr. in lip form. The sterile specimen, no. *653*, has a pseudobulb about 15 cm. long and smaller but obviously immature leaves. However it undoubtedly belongs to this species.

Zygopetalum Tatei A. &. S., sp. nov. Rhizoma repens. Pseudobulbi approximati, angusti, in apice diphylli, in sicco profunde sulcati. Folia oblanceolata vel elliptica, parvula, acuta, plus minusve petiolata, nervosa, subcoriacea. Scapus folia multo excedens. Racemus laxe pauciflorus. Flores speciosi. Perianthii segmenta late patentia. Sepalum dorsale lanceolatum. Sepala lateralia ovato-lanceolata. Petala oblonga vel oblanceolato-oblonga. Labellum cum hypochilio minuto, callo flabellato omnino occupato; epichilium reflexum grande patens, perlate ovato-rhombicum vel reniforme. Columna apice bialata. Pollinia quattuor.

Plant vegetatively small for the genus. Roots fibrous, flexuous, glabrous. Rhizome creeping, woody, concealed together with the lower part of the pseudobulbs by imbricating scarious ovate or triangular sheaths. Pseudobulbs approximate, 3.6 to about 6 cm. long, bifoliate at the apex, cylindric and very deeply sulcate (perhaps tetragonous) in the dried condition, sometimes slightly dilated below. Leaves oblanceolate to elliptic, 7.9–13.7 cm. long to the point of insertion, up to 2.3 cm. wide, acute, commonly gradually narrowed below to a more or less distinct petiole, rigid-nervose, subcoriaceous, with 3 nerves rather conspicuous beneath. Scape about 35–49 cm. tall excluding the flowers, base rising from below the pseudobulb and concealed by scarious sheaths, provided with 2–3 remote, tightly clasping tubular membranaceous sheaths. Raceme loosely 2–6-flowered. Rachis flexuous, up to 11.3 cm. long. Floral bracts ovate or triangular, acute or acuminate, spreading, concave, much shorter than the pedicellate ovary. Flowers with spreading segments. Dorsal sepal lanceolate, 2.41–2.7 cm. long, 8–9.5 mm. wide, acuminate, 5–7-nerved. Lateral sepals ovate-lanceolate, 2.5–2.85 cm. long, 1–1.1 cm. wide, acuminate, dorsally carinate above, the keel ending in a mucro, 7–8-nerved. Petals oblong or oblanceolate-oblong, slightly oblique, 2.3–2.65 cm. long, 7.1–8.4 mm. wide, acute, minutely apiculate, 5–7-nerved. Labellum divided into a very short basal portion or hypochile subparallel to the column and a large spreading epichile; hypochile 3.7 mm. long, entirely occupied by a fleshy fan-shaped, radiant-ribbed callus 7 mm. long, whose apex is high and free; epichile from a cuneate base abruptly ovate-rhombic or reniform, about 1.8–2.38 cm. long, 2.3–2.8 cm. wide, abruptly and more or less conspicuously acute or apiculate, more or less undulate on the margins. Column stout, much dilated at base, arcuate, about 1.1 cm. long at the back, with a pair of porrect fleshy triangular-rounded wings above. Pollinia 4, in 2 pairs of 1 large and 1 small, pyriform-ovoid.

Slopes of Ridge 25, 5500–6000 ft., *423* (type), flowers white with purple spots; crest of Ridge 25, 6300 ft., *468*, 2–3 ft. tall, flowers 3 or 4, 1.5 inch in diameter, lip white, petals green, blotched with purple. This latter collection has apparently a somewhat reniform but imperfect lip. *Zygopetalum Tatei* is unusual in having short leaves and relatively elongate scapes. In floral structure it seems quite similar to *Z. maxillare* Lodd.

MAXILLARIA sp. Agüita, 3100 ft., *941*. This caespitose plant with monophyllous pseudobulbs and attenuate sepals and petals is somewhat allied to *M. longissima* Lindl., but the flower is much too poor for exact diagnosis.

MAXILLARIA sp. (sterile) Desfiladero, 6000 ft., *1049*. This caulescent species recalls *M. Houtteana* Reichb. f.

MAXILLARIA BRENESII Schltr. Agüita, 3100 ft., *942*. The determination of this plant was made from the single flower, in an advanced stage of anthesis, contained in an envelope on the mounted sheet. The species was

formerly recorded only from Costa Rica, where it appears to be frequent.

MAXILLARIA DIVARICATA Cogn. Epiphytic in woods, Savanna Hills, 4400 ft., *828*, flowers an inch in diameter, yellow, with white on the lip. Formerly Brazil was the only recorded habitat of this species. The caulescent plants of this collection differ from the usual form of the species in that the floral bract is usually shorter than the ovary, the petals are 5-nerved instead of 7–9-nerved, and the flowers are noted as yellow, not green.

MAXILLARIA MERIDENSIS Lindl. Epiphytic on trees at Central Camp, 4800 ft., *562*, stems long, cinnamon brown, leaves soft; valley between Ridges 23B and 23C, *1038;* the following two collections which are sterile or fruiting also undoubtedly represent this species: *434*, from the slopes of Ridge 25 at 5500–6000 ft. and *715*, from Desfiladero at 6000 ft. The highlands of Venezuela are the only recorded habitat of this species.

ORNITHIDIUM sp. ? (sterile) Desfiladero, 6000 ft., *709;* a caulescent plant bearing no inflorescences.

ORNITHIDIUM sp. (sterile) Central Camp, 4800 ft., *579*. This caulescent species bears clustered peduncles in the axils of the spreading lorate leaves.

ODONTOGLOSSUM sp. ? Slopes of Ridge 25, 5500–6000 ft., *422*, 2–3 ft. high, flowers with yellow spots and blotches. This collection shows a plant with a stout creeping rhizome bearing sparse, very stout roots, distant monophyllous pseudobulbs, coriaceous elliptical leaves, and long strict peduncles crowned with very few-flowered racemes. The very imperfect flowers show a lip which is basally adnate to the column, and 2 pollinia without caudicles sessile on a subquadrate stipe.

PIPERACEAE[1]

Lowland species

PEPEROMIA MACROSTACHYA (Vahl) Dietr. Woods at Foothills Camp, 750 ft., *386;* known also from the Guianas and Brazil.

Piper esmeraldanum Trel. sp. nov. Fruticosa (?) nodosa; internodis floriferis gracilibus elongatis pubescentibus; foliorum laminis oblongo-lanceolatis vel elliptico-oblongis acuminatis penninerviis supra glabris, ad basin angustatis inaequaliter auriculatis; petiolis brevibus alatis pubescentibus auriculo majore obtectis; pedunculis brevibus subpubescentibus; bracteis triangulari-subpeltatis; coccis tetragonis apice impressis; stigmatibus 3 sessilibus.

A shrub (?) nodose; flowering internodes rather slender and elongate, crisp-pubescent; leaf-blades lance-oblong or elliptic-oblong, 16–21 cm. long, 7–8 cm. wide, acuminate, the narrowed base inequilaterally auriculate, pinnately nerved nearly throughout, the nerves about 15 on each side, drying

[1] By William Trelease.

thin, glabrous above; petioles 5 mm. long, winged, pubescent, covered by the larger auricle; spikes 5 cm. long, 5 mm. in diameter; peduncles 5 mm. long, subpubescent; bracts inconspicuous, triangular-subpeltate; berries tetragonal, impressed at the top; stigmas 3, sessile.

Forest at Middle Camp, Esmeralda, *354*.

Piper parimanum Trel. sp. nov. Fruticosa nodosa glabra; internodis floriferis brevibus crassiusculis; foliis elliptico-oblongis penninerviis ad basin aequaliter subacutis, petiolis non alatis; spicis juvenilibus brevissime pedunculatis; bracteis rotundatis subpeltatis.

A nodose glabrous shrub; flowering internodes short and comparatively thick; petioles about 5 mm. long, not winged; leaf-blades elliptic-oblong, 16–21 cm. long, 6–7.5 cm. wide, equilaterally subacute at base, pinnately nerved nearly throughout, the principal nerves 8 or 10 on each side, looping, impressed above and salient beneath; spikes as yet only 4.5 mm. long and 1 mm. in diameter, on very short stalks; bracts rounded, subpeltate.

At Middle Camp, Esmeralda, *370*.

Piper sangabrielanum Trel. sp. nov. Internodis floriferis brevibus gracilibus pubescentibus; petiolis brevibus non alatis; laminis lanceolato-ovatis sensim acuminatis ad basin rotundatis supra puberulis subtus pubescentibus ad nervos subhirsutis penninerviis; spicis crassis breviter pedunculatis retroflexis; bracteis rotundato-subpeltatis margine ciliatis; coccis immersis subglobosis vel tetragonis umbilicatis; stigmatibus 3 brevibus crassis.

A shrub (?); flowering internodes short and slender, crisp-pubescent, becoming hirtellous; leaves broadly lanceolate or lance-ovate, 10–11 cm. long, 4–4.5 cm. wide, gradually acuminate, the inequilateral base rounded but rather abruptly subacutely contracted, very sparsely crisp-pubescent above and more densely so beneath, pinnately nerved throughout, the nerves about 10 on each side, subhirsute beneath; spikes straight or arcuate, about 5 cm. long, 6 mm. in diameter, blunt, on refracted subhirtellous peduncles about 10 mm. long; bracts rounded-subpeltate, dark, the narrow pale margin ciliate; berries sunken in the rachis, subglobose or quadrate, umbilicate, the 3 short stigmas in the depression.

At San Gabriel on the Rio Negro, northern Brazil, *1002*.

Species of Mount Duida

Peperomia duidana Trel. sp. nov. Herba parva repens, caule gracile molliter subsericeo; foliis alternis late ovatis obtusis vel obtuse acuminatis cordatis in sicco subcoriaceis e basi 5-nerviis, nerva media crassiuscula ramosa, obscure pubescentibus praesertim ad venam mediam subtus; petiolis elongatis molliter pubescentibus; spicis axillaribus solitariis pedunculatis, pedunculis sub medio bracteatis; bracteis rotundo-peltatis; antheris majusculis ellipsoideis.

A moderately small repent herb; stems rather slender (scant 2 mm. in

diameter), softly subsilky; leaves alternate, broadly ovate, obtuse or blunt-acuminate, typically cordate, 15–30 mm. long, 15–25 mm. wide, drying subcoriaceous, indistinctly about 5-nerved from the base and with the rather heavy midrib obscurely branched, slightly pubescent, especially on the midrib beneath; petioles 15–25 mm. long, softly pubescent; spikes axillary, 15 mm. long, 2 mm. in diameter, solitary on slender glabrate stalks 30 mm. long, blunt-bracteate near the middle; bracts round-peltate; anthers moderately large, ellipsoid.

Slopes of Ridge 25, 5500–6000 ft., *438;* perhaps not separable from *Piper bracteatum* Thomps., of the Lower Caribbees, which usually is referred to *Peperomia scandens* R. & P., or from *P. urocarpa* F. & M., of Brazil.

Peperomia Tyleri Trel. sp. nov. Herba parva glabra subsimplex; caule crassiusculo; foliis alternis, ellipticis vel subrhombeis emarginatis basi acutis trinerviis, nerva media validiore obscure ramosa; petiolo breve ad basin amplectente decurrente; spicis elongatis gracilibus pedunculatis; bracteis rotundo-peltatis; coccis obpyriformibus submucronatis longe stipitatis; stigmatibus apicalibus.

A rather small epiphytic or terrestrial glabrous subsimple herb; stem 2 mm. in diameter; leaves alternate, becoming coriaceous and yellowish, elliptic or subrhombic, emarginulate, acute-based, 10–15 mm. wide, 15–30 mm. long, 3-nerved but with the heavier midrib obscurely but finally subrugosely branched; petioles 5 mm. long, clasping-decurrent; spikes 50–90 mm. long, 1–2 mm. in diameter, rather loosely flowered; peduncle 10 mm. long; bracts round-peltate; berries obpyriform, submucronate, on filiform stalks equaling or exceeding them in length; stigmas essentially apical.

On mossy tree-trunk, valley beyond Ridge 23 B, 5950 ft., *476* (type); in brook-bed under ledges, slopes of Ridge 25, 5500–6000 ft., *443.*

Peperomia hernandifolia (Vahl) Dietr. At Agüita, 3100 ft., *895.* The species ranges through tropical America from the West Indies to Bolivia.

Piper duidaense Trel. sp. nov. Fruticosa glabra nodosa flexuosa; internodis floriferis brevibus gracilibus; foliis lanceolatis utrinque acutis aut inferioribus elongato-ovatis basi rotundatis, subtus nigro-punctatis; petiolis brevibus non alatis aut inferioribus longioribus et ad apicem alatis; spicis gracilibus breviter pedunculatis; bracteis triangularibus subpeltatis; coccis trigonis apice depressis granulosis; stigmatibus 2–3 sessilibus.

A shrub, glabrous, nodose and somewhat zigzag; flowering internodes rather short and slender; petioles 5 mm. long and unwinged, or on the lower leaves 20 mm. long and winged to the end; leaf-blades finely black-granular beneath, pinnately nerved with 5 or 6 pairs of nerves from below the upper fourth, the lower elongate-ovate, rounded at base, 22 cm. long, 9 cm. wide, the

upper lanceolate, subequally acute at both ends, 13–21 cm. long, 5–7 cm. wide; spikes 90–125 mm. long, 3–5 mm. in diameter, on filiform peduncles 10–15 mm. long; bracts triangular-subpeltate, narrow-margined; berries trigonous, depressed at apex, granular; stigmas 2 or 3, sessile.

Agüita, 4000 ft., *906*.

Piper para-peltobryon Trel. sp. nov. Fruticosa (?) flexuosa glabra; internodis floriferis breviusculis gracilibus; petiolis gracilibus concavis non alatis; laminis lanceolatis vel lanceolato-ellipticis, utrinque acutis vel subacuminatis, penninerviis, subtus fusco-granulosis; spicis crassis pedunculis filiformibus; bracteis triangulari-subpeltatis anguste marginatis; ovario subgloboso; stylo breve crasso, stigmatibus 3.

A shrub (?) somewhat zigzag, glabrous; flowering internodes rather short and slender; petioles slender, 1 cm. long, concave, not winged; stipules 1 cm. long; blades lanceolate or lance-elliptic, 8–10 cm. long, 3–4 cm. wide, equally acute at both ends or subacuminate, slightly brown-granular beneath, pinnately nerved throughout, the nerves 6–10 on each side; spikes 15 mm. long, 4 mm. in diameter, on filiform peduncles 20 mm. long; bracts triangular-subpeltate with narrow pale margins; ovary subglobose; stigmas 3, outcurved, on a short thick style.

Desfiladero, 6000 ft., *711*.

ULMACEAE[1]

Lowland species

TREMA MICRANTHA (L.) Blume. Yucabí, on the Rio Negro, northern Brazil, *995*, *998*; a small tree of wide distribution in tropical America.

MORACEAE[1]

Lowland species

FICUS OBLANCEOLATA Rusby. Esmeralda Ridge, a small tree at foot of slope, *236*. The Venezuelan specimen seems to agree perfectly with the Rusby species described from Bolivia. Since it has so wide a distribution, it is probable that the tree has one or more earlier names, but it has not been possible to place it satisfactorily among the species described from Brazil or elsewhere.

Helicostylis obtusifolia Standley, sp. nov. Arbor, ramulis crassis densissime fulvo-pilosulis; folia subcoriacea petiolata, laminae obovato-oblongae apice obtusae vel rotundatae basi acutae, supra glabrae, subtus ad venas sparse minute pilosulae vel fere omnino glabrae; capitula mascula depressa multiflora fasciculata breviter pedunculata, basi bracteis parvis ovatis acutis sericeis involucrata.

[1] By Paul C. Standley.

A tree, with young branchlets stout, subterete, very densely pilosulous with short spreading fulvous hairs; stipules 4 mm. long, triangular, long-acuminate, strongly costate, densely pilosulous outside, sericeous within along the costa; leaves petiolate, subcoriaceous, entire, the petioles stout, 1–2.5 cm. long, glabrous or nearly so; leaf-blades obovate-oblong, 12–17 cm. long, 6–8 cm. wide, rounded or very obtuse at the apex, acute at the base, and slightly unequal, fuscous and glabrous on the upper surface, the costa rather prominent, beneath brownish, sparsely and minutely pilosulous along the veins or almost wholly glabrous, the costa slender, elevated, the veins about 9 pairs, slender, prominent, oblique, ascending at a rather wide angle, slightly arcuate, irregularly anastomosing near the margin, the ultimate veins prominulous and laxly reticulate; staminate heads fasciculate on naked branchlets, mostly in clusters of 3–5, depressed or subglobose, 3–5 mm. broad, subtended at the base by very numerous minute, ovate, acute, densely sericeous bracts, the peduncles stout, densely tomentulose, 4–6 mm. long.

Foothills Camp, Esmeralda, 750 ft., *389*. From all or the majority of the species of the genus this differs in its very obtuse leaves. The lack of pubescence on the leaves also distinguishes it from most of the species.

Helicostylis tomentosa (Poepp. & Endl.) Rusby. Middle Camp, Esmeralda, *949*. A small tree, ranging from Bolivia to the Guianas.

Trophis racemosa (L.) Urban. Middle Camp, Esmeralda, *947*. A small tree with greenish white flowers in slender spikes, widely dispersed in tropical America.

PROTEACEAE

Species of Mount Duida

Roupala montana Aubl. Crest of Savanna Hills, 4400 ft., *762;* Trinidad, Tobago, and French Guiana to Colombia.

LORANTHACEAE

Lowland species

Oryctanthes florulentus (Rich.) Urban. Yucabí, on the Rio Negro, northern Brazil, *1052;* widely distributed in tropical South America.

Oryctanthes botryostachys Eichl. In forest at Santa Isabel, northern Brazil, *101;* riverside at Macará, northern Brazil, *108;* widely distributed in tropical South America.

Phthirusa elongata Gleason, sp. nov. Caulibus rectis gracilibus glabris; foliis petiolatis coriaceis oblongis acuminatis subaveniis; paniculis angustis, in axillis foliorum superiorum fasciculatis; pedunculis trifloris brevibus; calyculo oblique truncato; petalis 6 anguste oblanceolatis crassis apice incurvatis; stamina minora: filamentis rectis, antheris quadratis apice longe lineari-rostratis; stamina majora: filamentis incrassatis supra medium valde constrictis, antheris parvis triangulari-cordatis apice breviter rostratis.

Stems slender, terete, glabrous, the internodes 4–6 cm. long; petioles 10–15 mm. long, concave above, very narrowly winged distally; blades firm and coriaceous, oblong, varying to ovate-lanceolate, 7–9 cm. long, 3.5–5 cm. wide, acuminate, broadly cuneate at base, the lateral veins obscure and reticulate; panicles slender, clustered in the upper axils, 4–7 cm. long, their axes strongly angular, lateral peduncles 1–3 mm. long, 3-flowered; calyculus oblique, 2 mm. long, with concave sides; calyx truncate or undulate, 2.2 mm. long, its margin slightly thinner; petals 6, narrowly oblanceolate, 2.5 mm. long, thick and leathery, slightly cucullate at the acute tip; short filaments thick, prismatic, 1 mm. long, their 4-celled anthers broadly quadrate, 0.4 mm. long, surmounted by a slender terete beak 0.7 mm. long (Fig. 4).

Middle Camp, Esmeralda, 500 ft., *946.* The species is probably related to *P. erythrocarpa* (Mart.) Eichl., also from the upper Amazon region, which has much larger flowers and glandular filaments. A similar inflorescence is found in *P. polystachya* Eichl., also with glandular filaments.

PHTHIRUSA STENOPHYLLA Eichl. A trailing, bushy shrub, riverside at Macará, northern Brazil, *110;* upper valley of the Rio Negro and its tributaries.

Species of Mount Duida

DENDROPHTHORA ELLIPTICA Krug & Urban, var. STENOPHYLLA Urban. Woods in Laterite Valley, Savanna Hills, 4400 ft., *783;* apparently only in Venezuela.

DENDROPHTHORA RORAIMAE (Oliver) Ule. Dry slopes of Savanna Hills, 4400 ft., *750;* crest of Ridge 25, 6300 ft., *400;* summit of Peak 7, 7100 ft., *642;* hitherto known only from the summit of Mount Roraima.

Phoradendron[1] duidanum Trel. sp. nov. Frutex epiphyticus furcatus, ramis longiusculis ad nodos cataphyllis suffultis, dioicus; internodis breviusculis crassis juventute subtetragonis; cataphyllorum jugis 3 tubulosis; foliis crassis nitentibus rotundato-ellipticis obtusissimis vel vix retusis; spicis solitariis vel 2, mediocribus, sub-5-nodosis; floribus usque 24; pedunculis brevibus ad basin bracteatis; coccis globosis opacis glabris; sepalis inflexis.

Scarcely forked, the rather long branches with cataphylls on all joints; dioecious? internodes comparatively short and thick, 20–60 mm. long, 3–5 mm. in diameter, wrinkled, the youngest subtetragonal; cataphylls a nearly basal pair followed by a second and third pair at intervals of 15 mm., tubular; leaves thick, glossy, round-elliptic, suboblique, 4–6 cm. long, 3–4 cm. wide, very obtuse or slightly retuse, subcuneately petioled for about 10 mm., very obscurely subpalmately nerved; spikes solitary or paired, moderate (40 mm.), with about 5 subfusiform joints scarcely 24-flowered in 6 or 4+2 series when pistillate; peduncles scarcely 10 mm. long, with basal scales; fruit round, dull, smooth, 3 mm. in diameter; sepals inflexed (Pl. 28, fig. 1).

[1] The genus *Phoradendron* by William Trelease.

Dry slopes of Savanna Hills, 4400 ft., *737*.

Phoradendron Tatei Trel. sp. nov. Frutex epiphyticus, furcatus, ramis longiusculis ad nodos cataphyllis suffultis; dioicus?; internodis mediocribus glabris vel vix papillosis compressiusculis; cataphyllorum jugis 3 bifidis; foliis crassis breviter petiolatis elliptico-subovatis subacutis vel emarginatis; spicis fastigiatis ad nodos 5 tumidos; floribus usque 12, 6-seriatis; pedunculo breve jugis 2 bractearum divergentium; sepalis arcte inflexis.

Scarcely forked, the rather long branches with cataphylls on all joints, dioecious?; internodes moderate, 30–60 mm. long, 3–5 mm. in diameter, smooth or slightly cellular-papillate, transiently somewhat compressed; cataphylls a nearly basal pair followed by two others at intervals of 10–20 mm., bifid; leaves thick, rather dull, commonly equilateral, elliptic-subovate, subacute to emarginate, 4–7 cm. long, 3–4.5 cm. wide, obscurely base-nerved, acutely petioled for scarcely 10 mm.; spikes clustered ?, 30 mm. long, 2 mm. in diameter, with about 5 swollen joints some 12-flowered in 6 series; peduncle about 5 mm. long with 2 pairs of divergent scales, sepals closely inflexed.

Slopes of Ridge 25, 5500–6000 ft., *450*.

Phthirusa gracilis Gleason, sp. nov. Glaberrima; ramis gracilibus elongatis; foliis parvis ovalibus obtusis subtus rugosis (in siccitate) supra venis inconspicuis elevatis adscendentibus notatis; spicis brevissimis in axillis solitariis; ternationibus sessilibus, calyculo breve; floribus 6-meris; calyce eroso-denticulato; petalis crassis anguste oblanceolatis; filamentis staminum minorum crassis prismaticis, majorum apice contractis; antheris late ovalibus apice brevissime obtusissime apiculatis.

Glabrous throughout; stems weak, slender, elongate; petioles subterete, rugose, 6–8 mm. long; blades firm, oval, varying to subrotund, 20–25 mm. long, 10–15 (rarely 18) mm. wide, obtuse or minutely apiculate, obtuse or rounded at base, the veins elevated on both sides when dry; spikes solitary in the axils, few-flowered, 1–2 cm. long; ternations sessile, the calyculus very short, obscurely oblique; calyx about 1 mm. long, erose-denticulate; petals 6, narrowly oblanceolate, 2.7 mm. long, thick and fleshy; filaments of the small stamens thick, prismatic, those of the large stamens slender in the distal third, 1.5 mm. long; anthers thick, oval, 4-celled, rounded above to a minute obtuse apiculum (Fig. 4).

Crest of Ridge 25, 6300 ft., *522;* quite distinct from other species of the genus in its small leaves, much reduced inflorescence, and character of the anthers.

PHTHIRUSA GUYANENSIS Eichl. Parasitic on *Humiria floribunda* Mart., var. *montana* (Juss.) Urban, Savanna Hills, 4400 ft., *785;* also in British Guiana.

Phthirusa punctata Gleason, sp. nov. Glaberrima; ramis novellis angu-

losis; petiolis mediocribus; laminis foliorum subcoriaceis ellipticis utrinque acutis, venis supra obscuris subtus obsoletis; paniculis brevibus paucifloris terminalibus; ternationibus breviter pedunculatis; calyculo ovato quam calyce breviore; calyce truncato integro vel obscure denticulato; petalis 6 mediocribus anguste oblanceolatis; filamentis staminum breviorum crassis prismaticis supra medium dense glandulosis; antheris triangulari-apiculatis, loculis externis quam internis duplo majoribus; filamentis staminum longiorum supra medium lateraliter concavis; antheris biloculatis apice appendiculo subterete ornatis.

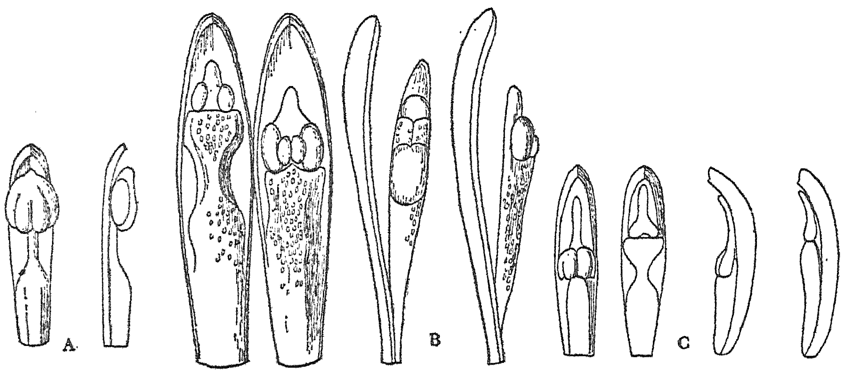


Fig. 4. Side and front views of perianth segments and stamens of A. *Phthirusa gracilis;* B. *Phthirusa punctata;* C. *Phthirusa elongata.* All $\times 10$.

Glabrous throughout except the filaments; smaller branches angular when dry, the internodes 15–30 mm. long; petioles rather slender, 5–8 mm. long, strongly channeled above and subalate; blades firm, elliptic, 3–5 cm. long by half as wide, acute at both ends, the few ascending veins inconspicuous above, obsolete beneath; panicles terminal, 3–5 cm. long, the axes strongly angular; ternations on peduncles 3–5 mm. long, subtended by oblong bracts 3 mm. long; calyculus ovate, acute; calyx 1 mm. long, truncate or obscurely denticulate; petals 6, narrowly oblanceolate, 4.7 mm. long; short stamens: filaments stout, prismatic, nearly as wide as the petals, densely glandular-punctate, especially distally; outer anther-sacs 0.5 mm. long and twice as long as the inner, the beak triangular, equaling the anther-sacs; long stamens: filaments 3.5 mm. long, deeply excavate on both sides above the middle, densely glandular distally and thinly so below the constriction; anthers 2-celled, the pollen-sacs ellipsoid, 0.4 mm. long, about equaling the blunt ovoid-oblong beak (Fig. 4).

Parasitic on *Archytaea multiflora* Benth., south bank of the Caño Negro, Savanna Hills, 4400 ft., *853*. It is apparently related to *P. polystachya* Eichl., differing in its smaller leaves, longer peduncles, densely glandular filaments, and longer anther-appendages.

PHTHIRUSA RUFA (Mart.) Eichl. A parasitic vine, dry slopes of Savanna Hills, 4400 ft., *745*. The typical feature of the species, which is endemic to the Amazonian forests, is the very long peduncled, densely spicate, simple inflorescence; our specimen is sterile and the identification has been made on foliar resemblance alone.

PHTHIRUSA THEOBROMAE (Willd.) Eichl. Central Camp, 4800 ft., *1025;* slopes of Ridge 25, 5500–6000 ft., *460*. Neither specimen is in good condition for study and the identification depends chiefly on foliage characters. The species is widely distributed through tropical America.

MENISPERMACEAE

Lowland species

Abuta velutina Gleason, sp. nov. Caulibus et petiolis tenuissime velutinis; foliis subcoriaceis late ovalibus vel subrotundatis apice apiculatis basi late cuneatis 7-nerviis supra subnitentibus subtus puberulis, petiolis laminas aequantibus; racemis fructiferis velutinis; drupis oblique ellipsoideis arcte griseo-velutinis.

A tree 25 ft. high, the smaller branches straight, subterete, very thinly velutinous; petioles slender, swollen at base and apex, 6–8 cm. long, pubescent like the stem; leaf-blades subcoriaceous, broadly oval to subrotund, 9–10 cm. long, 7.5–8.5 cm. wide when mature, cuspidate at the tip, rounded below to a broadly cuneate base, 7-nerved, the outer pair obscure and marginal, the secondaries obscure above, elevated and reticulate beneath, glabrous and somewhat shining above, minutely and sparsely puberulent beneath; fruiting racemes stout, equaling the petioles and similarly pubescent, abruptly enlarged at base, solitary or in two's or three's from greatly enlarged nodes, about 15–20-flowered; fruiting pedicels thick, woody, 6–10 mm. long; fruit obliquely ellipsoid, 25–30 mm. long, rounded above, somewhat narrowed at base, densely gray-velutinous.

Middle Camp, Esmeralda, 500 ft., *959*. The species is most closely related to *Abuta imene* (Mart.) Eichl., of the Rio Negro, which it resembles in general appearance, but from which it differs in its broader leaves cuneate at base and puberulent beneath and its densely pubescent fruit.

ANNONACEAE

Lowland species

ABEREMOA ASTEROTRICHA Diels. Foothills of Mount Duida, 750 ft., *881;* known only from the upper Amazonian forests.

ANAXAGOREA ACUMINATA St. Hil. A tree, foothills of Mount Duida, 750 ft., *882;* native of the Amazonian region.

ANNONA JENMANI Safford. In forest, Santa Isabel, on the Rio Negro,

northern Brazil, *105;* a common species in the Guianas and perhaps of much wider distribution.

ANNONA sp. Esmeralda, *306;* resembling *A. squarrosa* L.

BOCAGEA MULTIFLORA Mart. A tree, foothills of Mount Duida, 750 ft., *880;* known only from the upper Amazonian region.

GUATTERIA SESSILIS R. E. Fries. Shrub, rocky top of Esmeralda Ridge, *207;* apparently known only from this general region, where it was originally collected by Spruce.

GUATTERIA sp. A small tree on Esmeralda Ridge, *235*. This is probably the same as *Spruce 2965* from San Carlos, which has not yet been named.

GUATTERIA sp. River banks and flood sands at Muyrapenima, on the Rio Negro, northern Brazil, *72;* the material is insufficient for proper identification.

XYLOPIA GRANDIFLORA St. Hil. Rocky top of Esmeralda Ridge, *190*. The species is widely distributed through tropical South America, especially in the Amazonian forests.

MONIMIACEAE

Lowland species

SIPARUNA GUIANENSIS Aubl. At Santa Isabel, *980*, *981*, and Muyrapenima, *59*, on the Rio Negro, northern Brazil. The species is widely distributed through tropical South America and is especially common in the Amazonian lowlands.

LAURACEAE

Lowland species[1]

Ocotea esmeraldana Moldenke, sp. nov. Fruticosa; foliis ad summum ramorum non arctatis; laminis coriaceis, ovatis vel subovatis, obtusis, basi acutis, supra glabris, subtus tenuiter pilosis glabrescentibus; paniculis axillaribus multifloris quam foliis brevioribus, tenuiter albo-pilosis; perianthio campanulato 6-lobato glabro vel paullo piloso; staminibus exterioribus 6 non glandulosis, interioribus 3 ad basin glandulis magnis sessilibus suffultis, filamentis basi non lobatis; antheris 4-locellatis exterioribus 6 introrsis, interioribus 3 extrorsis.

Shrub; branchlets slender, densely and minutely pilose, becoming glabrous in age; petioles 4–9 mm. long, glabrate; blades coriaceous, nitidous, somewhat lighter beneath, ovate or somewhat obovate, 4–10 cm. long and 2–4 cm. wide, obtuse at apex, slightly revolute, abruptly acute at base, penninerved, glabrous above, very minutely pilose on the midrib and secondaries beneath, but becoming glabrous; inflorescence paniculate, axillary, many-

[1] By H. N. Moldenke.

flowered, usually shorter than the leaves, densely and minutely white-pilose; peduncles slender, 2–3.5 cm. long, minutely pilose or almost glabrate; perianth campanulate, 6-lobed, glabrous or slightly pilose, its tube short, about 0.7 mm. long, its lobes ovate, about 2.1 mm. long and 0.8 mm. wide; stamens 9, arranged in 3 series, the 2 outer series eglandular and somewhat larger than the inner biglandular series; staminate flowers: filaments about 2.6 mm. long, glabrous or slightly pilose, without any stipule-like lobes; anthers subtruncate or slightly emarginate, about 5.2 mm. long and wide, 4-celled, on the 2 outer series introrse, on the inner series extrorse; locelli or valves arranged in a square or with the two lower ones somewhat divergent; glands binary, basal, sessile, not enveloping the filaments, somewhat larger than the anthers; ovary small, subglobose, about 1 mm. long and wide, glabrous, ovulate; pistil minute, 0.2–0.4 mm. long, glabrous; pistillate flowers not seen.

Fish Creek, Esmeralda, *963* (type); Grand Savanna, section 1, *285*. This species appears to belong to the subgenus *Mespilodaphne* (Nees) Mez because of the fact that the ovary in the staminate flowers is ovulate and therefore probably fertile, and appears to be related to *O. spathulata* Mez. The latter, however, differs conspicuously in its much larger, heavier, and decidedly obovate or spatulate-obovate leaves which are more or less crowded at the ends of the branchlets, and by its few-flowered and ferruginous-hirsute inflorescence.

CASSYTHA FILIFORMIS Nees. Grand Savanna at Esmeralda, *291;* widely distributed in tropical America.

Species of Mount Duida[1]

Ocotea duidensis Moldenke, sp. nov. Arbor; laminis coriaceis ovatis acuminatis, basi abrupte acutis vel paullo obtusis, glabris, venis venulisque utrinque reticulatis; paniculis axillaribus et terminalibus bracteatis folia multo superantibus tenuiter albo-puberulentibus; perianthii tubo late campanulato glabro, lobis ovato-triangularibus puberulentibus; staminibus 9, seriebus 2 exterioribus eglandulosis, serie interiore glandulis magnis sessilibus binis ornata; filamentis basi non lobatis; antheris serierum 2 exteriorum introrsis interioris extrorsis.

Tree to about 40 feet tall; branchlets densely and minutely puberulent, becoming glabrous; petioles 5–10 mm. long, glabrous; blades coriaceous, nitidous, rather lighter beneath, ovate, 3–6 cm. long and 2–3.5 cm. wide, acuminate at apex, abruptly acute or somewhat obtuse at base, glabrous, vein and veinlet reticulation very conspicuous on both surfaces; inflorescence paniculate or somewhat thyrsoid, axillary and terminal, greatly surpassing the leaves, bracteate, sparsely and minutely white-puberulent; peduncles and pedicels puberulent; bracts ovate or spatulate, the ultimate ones lanceolate or linear-lanceolate

[1] By H. N. Moldenke, except one species.

and densely pilose; flowers pinkish-white, usually in groups of 3's on small side-branches of the peduncle, pilose or glabrate within, perianth-tube broadly campanulate, 1–1.3 mm. long, about 1.5 mm. wide, glabrous, perianth-lobes 6, ovate-triangular, 1–1.1 mm. long, 0.9–1.3 mm. wide, the inner somewhat larger and broader than the outer, obtuse, very minutely and sparsely white-puberulent; stamens 9, arranged in 3 series, the two outer series eglandular, the inner series with 3 pairs of large glands; staminate flowers not seen; pistillate flowers: filaments about 0.2 mm. long, glabrous, without stipule-like lobes; anthers about 0.6 mm. long and 0.4 mm. wide, rotund, on the two outer series introrse, on the inner series extrorse; locelli or valves not plainly visible, but appearing to be 4 and arranged in a square; glands at base of inner series of stamens large, binary, sessile, not enveloping the filament; ovary large, depressed-globose, about 1.04 mm. wide and 0.78 mm. long, glabrous; pistil short, about 0.5 mm. long; fruit ovoid, sometimes apiculate at apex, about 12 mm. long and 8 mm. wide, about a third included by the accrescent, bilobed, cupuliform fruiting calyx.

Agüita, 4000 ft., *910*. This species appears to belong to the subgenus *Oreodaphne* (Nees) Mez and to be related to *O. glauca* Mez, but the latter differs conspicuously in having longer leaves which are rubiginous beneath and in having its inflorescence few-flowered, ferruginous, shorter than the leaves, and with deciduous bracts.

Ocotea glaucophylla Moldenke, sp. nov. Fruticosa; laminis coriaceis oblongis, ovato-oblongis vel late ellipticis, obtusis vel rotundatis, basi obtusis, truncatis vel acutis, glabris, subtus glaucis; venis venulisque utrinque arcte reticulatis prominentibus; pedunculis axillaribus 1-floris folia excedentibus.

Bush; branchlets slender, terete or somewhat flattened and ampliate at the nodes, glabrous; internodes 1–2 cm. long; petioles somewhat dilated, 2–5 mm. long, glabrous; blades coriaceous, dark and nitidous above, glaucous beneath, varying from oblong to ovate-oblong or broadly elliptic, 2.5–4.5 cm. long and 2–2.5 cm. wide, obtuse or rounded at apex, varying from truncate to obtuse or abruptly acute at base, glabrous, vein and veinlet reticulation very prominent on both surfaces; inflorescence axillary, 1-flowered, usually surpassing the subtending leaf; peduncles slender, about 2 cm. long, glabrous; pedicel (in fruit) about 7–9 mm. long, gradually expanding into the accrescent cupula; flowers not seen; mature fruiting calyx cupuliform, subtruncate or sometimes somewhat 6-lobed; fruit ovoid, glabrous, partly included.

Crests of the Savanna Hills, 4400 ft., *763*. This species probably belongs to the subgenus *Oreodaphne* (Nees) Mez, as it greatly resembles *O. caesia* Mez in the color of its foliage and *O. cordata* (Meissn.) Mez in general habit. However, the former differs conspicuously from this species in its fewer, sessile, cordate, and much larger leaves, its few-flowered inflorescence, shorter pedicels, and conspicuous bracts. The latter differs

from this species in its few-flowered inflorescence, its fewer and smaller leaves which are subacute at the apex and subcordate at the base, and its shorter petioles. The collector describes the plant as having "small white flowers and a persistent calyx," and likewise adds the interesting note that "the leaves are held edgewise to the sun." Since there are no flowers present it is impossible to state with certainty to which subgenus of *Ocotea* this species belongs, but due to its apparent affinities with the two above-mentioned species, which are both members of the subgenus *Oreodaphne*, it is very probable that it belongs there too.

Ocotea revoluta Moldenke, sp. nov. Fruticosa; laminis coriaceis ovato-oblongis vel ovato-lanceolatis ad apicem obtusam acutatis, basi acutis vel acuminatis, supra glabris, subtus dense minuteque puberulentibus, venis venulisque utrinque obscuris vel obsoletis, marginibus revolutis; inflorescentia axillare pauciflora folia aequantibus vel quam foliis paullum brevioribus.

Shrub; branchlets obtusely tetragonal or subterete, grayish, glabrate; internodes 1–2 cm. long; petioles dilated, canaliculate, 3–7 mm. long, puberulent; blades coriaceous, nitidous above, ovate-oblong or ovate-lanceolate, 4–7 cm. long and 1.5–3.5 cm. wide, bluntly acute at apex, acute or acuminate at base, strongly revolute, glabrous above, densely and minutely puberulent beneath, the venation very inconspicuous on both surfaces; inflorescence axillary, apparently few-flowered, equaling or slightly shorter than the subtending leaf, often maturing only one fruit and thus appearing 1-flowered; peduncles about 3.5 cm. long, glabrate; pedicels about 7.5 mm. long, gradually expanded into the accrescent cupuliform fruiting calyx which is about 6–7 mm. long and 9 mm. wide; flowers not seen; fruit oblong, somewhat flattened at each end, about 16 mm. long and 9 mm. wide, glabrous, about a fourth included by the mature calyx.

Slopes of the Savanna Hills, 4400 ft., *821*. Inasmuch as no flowers of this species have been seen it is impossible to state definitely to what subgenus of *Ocotea* it belongs. In fact, when flowers are available for study they may reveal that the species does not even belong to this genus. However, the great similarity in habit of this species with that of members of the genus *Ocotea* and the resemblance of the cupula and fruit seem to indicate that it has been correctly placed.

Ocotea venosa Gleason, sp. nov. Arbor glabra; petiolis brevissimis crassis; foliorum laminis oblongo-ellipticis, crasse coriaceis, in sicco brunneis, basi late obtusis, apice subacutis, utrinque insigniter reticulato-venosis; inflorescentia parva, ramis ramulisque angulatis pedicellis elongatis; floribus parvis lobis exterioribus obovato-oblongis, interioribus subrotundis; filamentis seriei I et II brevissimis, seriei III longioribus basi glandulis binis magnis auctis; antheris 6 exterioribus quadratis introrsis 4-valvatis, interioribus poris 2 in-

ferioribus latero-introrsis, 2 superioribus latero-extrorsis dehiscentibus; ovario glabro.

A small bushy tree, glabrous throughout; leaves crowded at the ends of the branches, on stout swollen petioles 3–5 mm. long; blades coriaceous, opaque, brown when dried, oblong-elliptic, the largest 13 by 6 cm., broadly subacute or obscurely and obtusely apiculate, broadly cuneate, obtuse, or subrotund at base; lateral veins ascending at an angle of about 50°, with the numerous veinlets conspicuously reticulate; inflorescence paniculate, floriferous above the middle, 5–7 cm. long, its branches strongly angled and with minute, fleshy, brown, depressed bractlets at each node; pedicels 2–4 mm. long, slender; outer perianth-segments obovate-oblong, 1.7 mm. long, 1.3–1.4 mm. wide; inner segments subrotund, 1.5 mm. long, 1.3 mm. wide, minutely ciliate distally; filaments of the outer series 0.2 mm., of the second series 0.1 mm., of the third 0.5 mm. long, the latter each with a pair of subglobose, yellow, fleshy glands 0.5 mm. in diameter; anthers of series I and II broadly quadrate, 0.7–0.8 mm. long and nearly as broad, with 4 introrse pores at two levels; anthers of series III opening by 2 latero-introrse pores near the base and 2 latero-extrorse pores near the summit; ovary of the staminate flowers slender, glabrous; pistillate flowers not seen.

Near the summit of Peak 7, 7050 ft., *676*. The species appears to be related to *O. crassifolia* (Nees) Mez, of Roraima, but differs in its shorter petioles and blunter, more prominently reticulate leaves.

SARRACENIACEAE

Species of Mount Duida

The sole genus of pitcher-plants in South America, so far as known, is *Heliamphora*. The original species, *H. nutans* Benth., was collected on Mount Roraima many years ago by Schomburgk; it has been obtained from the same place subsequently by all other collectors on Roraima, and is rarely seen in cultivation. The numerous specimens in herbaria maintain with great constancy the structural characters originally noted by Bentham. Since the other two genera of the family are both North American, the presence of this isolated genus on Roraima raises phytogeographical questions of great interest for which we have at present no answer whatever.

Heliamphora has always been considered monotypic. MacFarlane, in his recent monograph of the family, suggested that the plant "may yet be found on some of the 'Eppellings' or abrupt mountains between Roraima and the Rio Negro." So far his prophecy has not been fulfilled as to the species, but the Tyler-Duida expedition has discovered three others,

constituting perhaps its most remarkable contribution to botanical science.[1]

At the present time the genus is accordingly known to contain four species and these may be distinguished by the following brief key:

Pitchers expanded in the middle, the lid 1 cm. long, rotund, and sessile; bracts rounded to a cuspidate summit; pedicels slender, drooping, glabrous or minutely pubescent; perianth-segments ovate; anthers 3 mm. long *H. nutans.*

Pitchers barely or not at all expanded in the middle, the lid 2–3 cm. long, stipitate or narrowed at base; bracts acuminate at the apex; pedicels stout, erect or nearly so, usually pubescent; perianth-segments large, elliptic; anthers 7–8 mm. long.

Pitchers glabrous within, except for a few scattered hairs at the very margin; perianth-segments obtuse *H. Macdonaldae.*

Pitchers pubescent within; perianth-segments acuminate.

Lid cuspidate at the summit; pedicels very sparsely pubescent *H. Tatei.*

Lid rounded at the summit; pedicels densely pubescent *H. Tyleri.*

Heliamphora Macdonaldae Gleason, sp. nov. Amphoris infra medium obscure expansis apice rotundatis margine sparse ciliatis pilis reflexis intus glabris; laminis stipitatis rotundis; scapa inferne glabra superne cum pedicellis crassis erectis pubescente; bracteis ovatis acuminatis; perianthii segmentis ellipticis obtusis ad 63 mm. longis 40 mm. latis.

Pitchers elongate, 2–4 dm. long, somewhat distended below the middle, broadly rounded at the summit, sparsely ciliate around the margin of the orifice, glabrous within, strongly ciliate on the lamellae, conspicuously pubescent on the midvein; lid rotund, 2 cm. in diameter, veiny, glabrous, umbonate on the back, on a flattened stipe 1 cm. long; inflorescence 6 dm. high, 2-flowered, the stout scape glabrous or sparsely pubescent to the lowest bract, finely pubescent above, sometimes bearing near the middle a leaf intermediate in

[1] This genus, until recently known only by the single species *H. nutans* of Mount Roraima, is found to attain a remarkable development on Mount Duida. No less than three additional species have been discovered on the latter mountain. Pitcher-plants, closely packed together, occur in patches on practically all the ridge crests adjoining the escarpment, those on Ridge 25 being *H. Tatei*, while those of Ridge 7 at High Point are described as *H. Macdonaldae.* In general habit of growth these two are much alike. On the other hand, *H. Tyleri* of the Savanna Hills grows tall and erect, reaching a height of four feet, and apparently is not packed tightly together in mats. It is scattered sparingly through the undergrowth of the *Tyleria* forest of the slopes and valleys in the interior of the plateau.

The question arose, while we worked at High Point Camp, as to how the pitchers, closely packed and unable to bend over as they were, maintained a constant water-level and succeeded in getting rid of the excess water poured into them during the frequent heavy rains. Upon examination it was found that each leaf had a small pore in the seam (opposite the midrib), placed just at the juncture of the basal, water-containing part of the pitcher and the terminal portion, through which excess fluid might run out. This observation was made on *H. Macdonaldae*, but in all probability holds for the other species as well.—G. H. H. T.

size and structure between the bracts and the pitchers; bracts ovate, 7–8 cm. long, tapering to an acuminate apex; pedicels stout, about 5 cm. long, erect or slightly spreading, finely pubescent; perianth-segments broadly elliptic, obtuse, about 63 by 40 mm (Pl. 27, fig. 1).

Top of Peak 7, 7100 ft., *1022* (type); on Burned Mountain, Ridge 22A, 6700 ft., *1023*. The perianth-segments of the latter are much narrower, ranging from 14 to 23 mm. The absence of hairs from the inner surface of the pitchers is noteworthy.

Heliamphora Tatei Gleason, sp. nov. Caule valido crasso amphoras 8–15 gerente; amphoris infra medium non expansis apice acutis ciliatis intus dense strigosis pilis albis reflexis; laminis late obovatis insigniter cucullatis dorso umbonatis apice cuspidatis basi angustatis; scapa valida glabra compressa; pedicellis glabris vel minute puberulis; bracteis anguste ovatis acuminatis; perianthii segmentis ellipticis acuminatis ad 68 mm. longis 42 mm. latis.

Plant very stout, four feet high, densely leafy below; pitchers 4–5 dm. long, not dilated below the middle, very gradually widened to the top, triangular at the apex, the orifice ciliate and densely strigose with white reflexed hairs within, ciliate on the lamellae, glabrous on the midvein; lamina obovate, 3 cm. long, strongly cucullate, umbonate on the back, sharply cuspidate, narrowed to a broad base; scape stout, glabrous, more or less compressed; bracts ovate, 8–10 cm. long, acuminate; pedicels comparatively slender, erect or slightly curved, glabrous or very minutely pubescent; perianth-segments elliptic, sharply acuminate, as much as 68 mm. long by 42 mm. wide.

On the crest of Ridge 25, 6300 ft., *453*. On the older pitchers the lamina becomes stiff and indurated and its cuspidate apex is somewhat uncinate.

Heliamphora Tyleri Gleason, sp. nov. Amphoris infra medium non expansis apice late triangularibus margine dense ciliatis intus dense strigosis pilis albis reflexis; laminis late obovatis apice rotundatis ad basin angustatis; caule folioso; pedunculo valido cum pedicellis crassis erectis pubescente; bracteis ovatis acuminatis; perianthii segmentis ellipticis acuminatis et aristatis 60 mm. longis 25 mm. latis.

Pitchers elongate, 3 dm. long, not expanded below, very slightly expanded at the broadly triangular summit, ciliate on the lamellae and the orifice, glabrous on the midvein, densely strigose within with white reflexed hairs; lid broadly obovate, 3 cm. long, 2 cm. broad, rounded at the summit, scarcely umbonate, triangularly narrowed to the base; inflorescence at least 4 dm. high and probably much more; scape stout, pubescent throughout; bracts ovate, 8–15 cm. long, cuneate at base, acuminate to the apex; perianth-segments elliptic, acuminate and aristate, about 60 mm. long by 25 mm. wide (Pl. 27, fig. 2).

Savanna Hills, 4400 ft., *1044* (type); Brocchinia Hills, 4400 ft., *592*.

DROSERACEAE

Lowland species

DROSERA COMMUNIS St. Hil. East Swamp at Esmeralda, *250*. The species has a wide range in South America, extending from Colombia to Paraguay at low or moderate altitudes.

DROSERA MONTANA St. Hil. In sandy soil, Foothills Savanna, Esmeralda, 750 ft., *391*. The species in its typical form has been known hitherto only from southern Brazil and Bolivia, with two varieties on Mount Roraima.

Species of Mount Duida

DROSERA MONTANA St. Hil., var. ROBUSTA Diels. Top of Ridge 25, 6300 ft., *481;* slopes of Peak 6, 6900 ft., *674;* hitherto known only from its type locality on Mount Roraima.

PODOSTEMONACEAE[1]

Lowland Species

RHYNCHOLACIS HYDROCICHORIUM Tul. On granite rocks exposed by falling river, Camanaos on the Rio Negro, northern Brazil, *126;* also known from British Guiana.

CUNONIACEAE[1]

Species of Mount Duida

WEINMANNIA CRENATA Presl. A small tree on Agüita Slope, 4000 ft., *867;* an Andean species. The Duida specimen, which is sterile, also suggests *W. caripensis* HBK., which is more to be expected there.

WEINMANNIA VENEZUELENSIS Killip & Smith. Summit of Peak 7, 7100 ft., *627;* a shrub 2–3 ft. high on the slopes of Ridge 25, 5500–6000 ft., *461;* a common species of northern Venezuela and known also from Mount Roraima.

ROSACEAE

Lowland species

COUEPIA LEPTOSTACHYA Benth. A tree in flooded ground, Camanaos, on the Rio Negro, northern Brazil, *124*. The species was originally collected at Manáos.

HIRTELLA AUREO-HIRSUTA Pilger. A shrub in thick forest at Preguisa, on the Rio Negro, northern Brazil, *146;* Middle Camp, Esmeralda, *372*. It has been known previously only from the original collection of Weberbauer at Moyobamba, Peru.

[1] By Albert C. Smith.

HIRTELLA ULEI Pilger. Berries red, ripening black, Grand Savanna, Esmeralda, *287*. The only other collection is Ule's type from the Rio Negro.

Species of Mount Duida

Parinarium canescens Gleason, sp. nov. Ramis petiolis et inflorescentia dense fulvo-pubescentibus; stipulis triangulari-ovatis minutis mox deciduis; petiolis brevibus crassis; laminis coriaceis ovato-oblongis acutis basi rotundatis supra glabris subnitentibus subtus arcte canescenti-lanatis; inflorescentia parva terminale et in axillis superioribus pauciflora; hypanthio sericeo; sepalis sericeis triangulari-ovatis; petalis late ellipticis deciduis; staminibus fertilibus unilateralibus 13, anantheribus brevibus subulatis circa 5; ovario dense villoso sub insertione styli retrorse villoso, ovulis 2; stylo glabro.

A small tree, the branches conspicuously roughened with lenticels, the younger branches shallowly many-sulcate and densely pubescent with tawny hairs; stipules triangular-ovate, 1 mm. long, soon deciduous; petioles stout, 3 mm. long, pubescent like the stem; leaf-blades coriaceous, ovate-oblong, 4–5 cm. long by half as wide, acute or subacuminate, rounded at base, their upper surface smooth and shining, the veins impressed and the midvein thinly pubescent, their lower surface densely canescent-lanate with short hairs, the veins prominently elevated, the lateral veins curved-ascending at an angle of 45°, the veinlets conspicuous and subparallel; inflorescence few-flowered, terminal and in the upper axils, 1–2 cm. long, pubescent like the stem, the pedicels 1 mm. long; hypanthium sericeous, turbinate-campanulate, 5 mm. long, densely retrorsely villous at the throat within and thinly so toward the bottom; sepals triangular-ovate, 3.7 mm. long, 2.3 mm. wide, thinly sericeous; petals soon deciduous, broadly elliptic, 3.4 mm. long, 2.4 mm. wide, rounded at both ends, 3-nerved from the base, only the lateral nerves branching above; fertile stamens 13, the filaments as much as 8 mm. long, glabrous, with round-cordate anthers; sterile stamens 4 or 5, subulate, 0.4–0.7 mm. long, opposite the ovary; all filaments united at base into a narrow ring 0.3 mm. high; ovary inserted at the edge of the hypanthium under the fertile stamens, round-ovoid, 2 mm. long, densely villous with erect hairs and retrorsely villous in a narrow strip below the insertion of the style; ovules 2; style lateral, slender, glabrous, 8.5 mm. long.

On Agüita Slope, 4000 ft., *870*. The species bears a habital resemblance to *P. campestre* Aubl., a common species of the Guianan lowlands, but has deciduous stipules, much smaller leaves, and smaller flowers. Apparently few species of the genus have so many fertile stamens, seven or eight being the general rule.

CONNARACEAE

Lowland species

CONNARUS SPRUCEI Baker. In forest at Santa Isabel, on the Rio Negro, northern Brazil, *90;* a native of the upper Amazonian region.

MIMOSACEAE

The collection includes two species of *Inga*, *107* from the Rio Negro and *311* from Esmeralda, and a *Mimosa*, *134*, from Yucabí, none of which is in condition to be identified satisfactorily. Two sterile plants of this family were collected on Agüita Slope of Mount Duida at an elevation of 4000 ft., *896* and *905*, and one from the summit of the mountain, *863*.

CAESALPINIACEAE[1]

Lowland species

BAUHINIA sp. Santa Isabel on the Rio Negro, *978*.

CAMPSIANDRA ANGUSTIFOLIA Spruce. Along the Rio Negro in northern Brazil at Macará, *112*, and Tarira, *113;* a native of the Amazonian region.

CASSIA sp. A small tree at Esmeralda, *234*.

HETEROSTEMON ELLIPTICUM Mart. San Gabriel on the Rio Negro, northern Brazil, *138;* probably the only known locality for the species.

Macrolobium confertum Gleason, sp. nov. Sect. *Outea:* ramis novellis molliter denseque velutinis; petiolis brevissimis; foliola confertis circ. 30-jugis basi valde obliquis, oblongis, apice rotundatis vel paullum retusis et apiculatis utrinque glabris, in rachide supra et subtus pubescente; racemis multifloris tenuiter pubescentibus, ex axillis superioribus, floribus brevissime pedicellatis; sepalis magnis 2 elliptico-oblongis, parvis 3 triangulari-lanceolatis; petalo unico unguiculato lamina rotundata; ovario et stylo inferne piloso.

Branches slender, when young densely and softly pubescent with brown hairs, later glabrescent; petioles densely pubescent, 2–3 mm. long; rachis pubescent above and beneath, essentially glabrous on the sides, 8–11 cm. long; leaflets 25–40 pairs, 2–3 mm. apart, sessile, narrowly oblong, the lower 10–15 mm. long, 2–3 mm. wide, strongly oblique and inequilateral at base, apiculate at the rounded or slightly retuse summit, glabrous on both sides, paler and conspicuously veined beneath; racemes several, erect from the upper axils, 3–5 cm. long, floriferous from the base, the axis minutely pubescent, the pedicels 1.5 mm. long; large sepals 2, oblong-elliptic, 7 mm. long, sharply acuminate, cinereous-pubescent; small sepals triangular-lanceolate, 3 mm. long; claw of the single petal stout, 5 mm. long, ciliate below, its blade rotund, 5 mm. wide, 4 mm. long; stamens 3, their filaments very slender, flexuous, glabrous, 2 cm. long, the anthers broadly elliptic; ovary obliquely fusiform, 2 mm. long, pilose, on a slender stipe 3 mm. long; style 15 mm. long, pilose below.

Foothills Camp at Esmeralda, 750 ft., *375;* the leaves and branches spread horizontally. About twelve species of the section have been de-

[1] By N. L. Britton, except one species.

scribed, of which only two resemble ours sufficiently to need comparison. *M. brevense* Ducke has leaflets without the terminal apiculum, considerably wider and farther apart, pubescent on the veins above, and inserted on a conspicuously winged rachis. *M. Huberianum* Ducke is somewhat closer, but differs in its rachis, which is pubescent along the sides, and in its leaflets, which are larger, never retuse at the summit, and twice as far apart on the rachis.

MACROLOBIUM DISCOLOR Benth. A shrub on the Grand Savanna at Esmeralda, *289;* hitherto known only from the upper Rio Negro.

PEIRANISIA MULTIJUGA (Rich.) Britt. & Rose. Preguisa on the Rio Negro, northern Brazil, *145;* widely distributed in tropical America.

SCHNELLA sp. Santa Isabel on the Rio Negro, northern Brazil, *102*.

TOUNATEA sp. Foothills of Mount Duida, 750 ft., *899*.

FABACEAE

Lowland species

CLITORIA LAURIFOLIA Poir. Yucabí, on the Rio Negro, northern Brazil, *131;* West Indies to Colombia and southern Brazil.

DESMODIUM BARBATUM Sw. Manáos, *37;* widely distributed in tropical America.

DESMODIUM UNCINATUM (Jacq.) DC. In second-growth forest, Santa Isabel, on the Rio Negro, northern Brazil, *99;* widely distributed through tropical America.

DIOCLEA LASIOCARPA Benth. In forest at Santa Isabel, *96;* widely distributed through northern South America.

LONCHOCARPUS URUCU Killip & Smith.[1] (?) Esmeralda, *965*, where it is known as "barbasco" and used to poison fish. The specimen is sterile and is not referred here with certainty. The species is so far known only from Gurupá, in the state of Pará, but is to be expected along tributaries of the Amazon and Negro.

PTEROCARPUS ROHRII Vahl. In forest, Mauri-mucaua, on the Rio Negro, northern Brazil, *106;* Guianas and the Amazon Valley.

ZORNIA DIPHYLLA (L.) Pers. In second growth at Santa Isabel, on the Rio Negro, northern Brazil, *100;* common and widely distributed through tropical America.

A stout woody vine in fruit, from Esmeralda, *964*, can not be named in its present condition; an herbaceous vine from Esmeralda Ridge, *275*, is probably a species of *Phaseolus*.

[1] By Albert C. Smith.

LINACEAE

Lowland species

Roucheria angulata Gleason, sp. nov. Foliorum laminis membranaceis nitentibus obovato-oblongis abrupte cuspidatis basi ad petiolum subalatum longe cuneatis; panicula jam fructifera; sepalis maturis suborbicularibus crassis opacis medio carinatis margine membranaceis ciliolatis; baccis ellipsoideis exocarpo tenue, endocarpo ellipsoideo 5-angulato lateribus concavis; stylis 5 persistentibus, stigmatibus capitatis.

A small tree, the straight slender branches glabrous; leaf-blades obovate-oblong, broadest well above the middle, 13–18 cm. long, 5.5–8 cm. wide, membranous, shining, abruptly cuspidate, long-cuneate at base into a winged petiole 20–25 mm. long, strictly glabrous, the lateral veins finely reticulate, spreading at an angle of about 70°; panicles terminal, freely branched, many-flowered, 7 cm. long, minutely puberulent; pedicels very short; fruiting sepals almost circular, thick, brown, opaque, carinate in the center, membranous toward the edge, minutely ciliolate; fruit ellipsoid; exocarp thin; endocarp ellipsoid, 7 mm. long, 4 mm. in diameter, prominently and sharply 5-angled with concave sides; seeds elongate; styles 5, persistent, 1 mm. long, with capitate stigmas.

Middle Camp, Esmeralda, *347*, *950* (type). It resembles *R. humiriifolia* Planch., but its leaves are thinner, more shining, longer attenuate at the base, more abruptly cuspidate at the apex, while the sharply angled endocarp is quite unlike that of *R. humiriifolia*, which is 5-sulcate with convexly rounded sides.

Species of Mount Duida

ROUCHERIA LAXIFLORA Winkl. This species, rather recently described from Bolivia, has been known apparently only from the type collections, *Buchtien 2059* and *2106*, in which the flowers are too immature to admit of complete description. A specimen of a tree 30 ft. high, from Agüita, 3800 ft., *924*, can not be distinguished from the type in foliage and is referred here without hesitation. Since it bears fully developed flowers, the following amended description of the floral structure is presented.

Sepals broadly ovate, 2 mm. long, 1.5 mm. wide, whitish at the margin, very thinly puberulent on the back; petals yellow, narrowly ovate-oblong, 4.5 mm. long, 2.2 mm. wide, rounded at the summit, flabellately veined, very minutely puberulent; stamens 15, connate at base into a tube 1 mm. high and slightly pubescent around its margin; filaments very irregular in length, from 1.5 to 3.5 mm. long, very slender, glabrous; anthers stoutly ovoid, dorsifixed, 2-celled, opening longitudinally; ovary conic, 2 mm. long, acuminate into the styles; styles 2–4, slender, 1.5 mm. long, more or less outwardly curved near the summit; stigma oblique, horseshoe-shaped.

HUMIRIACEAE

Lowland Species

HUMIRIA BALSAMIFERA Aubl. Tree Savannas at Esmeralda, *330*, *331*. The species is known to exist from this general region east to French Guiana.

HUMIRIA FLORIBUNDA Mart., var. LAURINA (Klotzsch) Urban. Rocky top of Esmeralda Ridge, *209;* on the Grand Savanna at Esmeralda, *283;* originally collected and apparently known hitherto only from British Guiana.

HUMIRIA FLORIBUNDA Mart., var. **spathulata** Gleason, var. nov. Foliis ellipticis, usque ad 60 mm. longis 25 mm. latis, apice obtusis vel subretusis, basi angustatis in petiolum alatum.

Leaf-blades elliptic, as much as 25 by 60 mm. in size, obtuse or obscurely retuse, narrowed at base into a winged petiole 8–12 mm. long and 3–5 mm. wide.

On the Grand Savanna at Esmeralda, *286*.

Humiria savannarum Gleason, sp. nov. Ramulis minute pubescentibus mox glabrescentibus; foliis subcoriaceis anguste ellipticis ad apicem obtusum subacuminatis, obscure crenulatis, basi cuneatis in petiolum brevissimum, ad venas pubescentibus ceterum glabris; inflorescentia ramosa folia superante; sepalis rotundis; petalis oblongo-lanceolatis, subacutis, supra medium pubescentibus; staminibus 20 ad medium connatis; antheris basi barbatis connectiv apice producto acuminato.

Young branches minutely pubescent, the epidermis soon becoming detached and the older branches thenceforth glabrous; leaves spirally arranged, their blades subcoriaceous, narrowly elliptic, as much as 25 by 80 mm., subacuminate to an obtuse apex, very obscurely crenulate or subentire, cuneate at base to a petiole 1–2 mm. long, the midvein conspicuously pubescent beneath and obscurely so above, the surface glabrous, the margin beneath with a series of dark impressed glands; inflorescence somewhat exceeding the leaves, freely branched and many flowered, the peduncle mostly 4–5 cm. long; bracts subulate, 2–3 mm. long; upper branches and the very short pedicels finely pubescent; sepals broadly rotund, irregular in size, the largest about 1 mm. long; petals oblong-lanceolate, 4–4.5 mm. long, subacute, finely pubescent along the middle in the distal half; stamens 20; filaments alternately 3.7 and 4.3 mm. long, connate to near the middle, the free portion closely beset with four rows of minute processes; anthers densely setose at the base, the connective prolonged and acuminate; disk of 20 fleshy, narrowly fusiform, more or less connate segments 0.8 mm. long; ovary spherical, glabrous, 1.2 mm. in diameter; style 2.7 mm. long, hirsute on the basal half.

On the Tree Savannas at Esmeralda, *330*. The species resembles *H. floribunda* Mart., var. *laurina* (Klotzsch) Urban in its general appearance, but differs in its hairy petals and midvein, its glabrous ovary, and its densely long-setose anthers.

SACCOGLOTTIS OBLONGIFOLIA (Benth.) Urban. A small tree at San Gabriel, on the Rio Negro, northern Brazil, *142*, where it was originally collected by Spruce. It is known only from the region of the Rio Negro and the Casiquiare.

Species of Mount Duida

HUMIRIA FLORIBUNDA Mart., var. MONTANA (Juss.) Urban. Dry slopes of Savanna Hills, alt. 4400 feet, where it forms a bushy tree, *733*. It has been known previously from the mountainous regions of southeastern Brazil.

RUTACEAE

Lowland species

MONNIERIA TRIFOLIA L. At Yucabí on the Rio Negro, northern Brazil, *129;* widely distributed throughout tropical America, often as a weed.

Species of Mount Duida

Ravenia linearis Gleason, sp. nov. Foliis linearibus crassis glabris praeter nervum medium obscure strigosum; pedunculis in axillis superioribus multifloris; sepalis imbricatis foliaceis ovato-lanceolatis obtusis 2 exterioribus majoribus; corolla tubulosa zygomorphia, lobo dorsale oblongo, 2 lateralibus semi-obovatis, 2 ventralibus connatis obovatis; staminodiis subulatis pubescentibus mediano quam lateralibus dimidio breviore; staminibus 2 basi appendiculatis.

A shrub 6 dm. tall with white flowers; stem slender, sparsely strigose above, especially at the nodes, becoming glabrous below, the internodes 2–5 mm. long; leaves opposite; petioles slender, sparsely strigose, about 5 mm. long; leaf-blades thick and appearing revolute, narrowly linear, 3–4.5 cm. long, 1.5–2.5 mm. wide, sparsely punctate, acute, entire, scarcely narrowed into the petiole, obscurely strigose on the midvein, the lateral veins obsolete; peduncles from the axils of the upper leaves, 10–15 mm. long, sparsely strigose, many-flowered; flowers almost sessile; sepals foliaceous, ovate-elliptic, obtuse, thinly strigose, the larger 1.8 mm. long, the smaller 0.8–1.1 mm. long; corolla-tube slightly curved, 4 mm. long, sparsely pubescent; dorsal corolla-lobe oblong, 2.7 mm. long; lateral lobes semi-obovate, 2.9 mm. long; ventral lobes completely connate into a single narrowly obovate lobe 3 mm. long, the lobes all obtuse, minutely cucullate, very sparsely pubescent without; filaments triangular, 0.3 mm. long; anthers 2, narrowly elliptic, 1.5 mm. long, their blunt appendages 0.3 mm. long; staminodes subulate, the two lateral 1.7 mm. long,

the median 0.9 mm. long and inserted higher up; disk entire, 0.4 mm. high, slightly shorter than the 5-carpelled ovary; style slender, straight, glabrous, 2.4 mm. long.

Streambed at Central Camp, 4800 ft., *531*.

Ravenia Tatei Gleason, sp. nov. Foliis oblongis vel obovato-oblongis crassis acutis basi obtusis breviter petiolatis, nervo medio petiolo et caule strigoso; pedunculis in axillis superioribus 1–2-floris; sepalis imbricatis foliaceis 2 exterioribus majoribus; corolla tubulosa zygomorphia strigosa, lobis 4 aequalibus semi-ovatis 1 oblongo breviore; staminodiis pubescentibus medio quam lateralibus multo breviori; staminibus 2 basi appendiculatis.

A shrub with light red flowers, height not stated; stem densely strigose, the upper internodes 10–15 mm. long; leaves opposite; petioles stout, densely strigose, 2 mm. long; blades subcoriaceous, bright green, oblong or obovate-oblong, 25–38 mm. long, 14–18 mm. wide, acute or obscurely acuminate, entire, densely ciliate, obtuse to rotund at base; upper surface deeply punctate, glabrous, the midrib strigose; lower surface strigose on the midvein, the prominent lateral veins curved-ascending, sparsely strigose; peduncles from the upper axils, 10–15 mm. long, densely strigose, 1–2-flowered, the pedicels very short; bracteole linear-subulate, hirsute, 3 mm. long; large sepals 2, ovate, 6 mm. long, 3.2 mm. wide, subacute, 1-nerved, hirsute-ciliate on the margin, hirsute on the midvein and densely glandular on the surface of the outer side, sparsely pubescent on the inner side; small sepals 3, 3.2 mm. long, 0.8–1 mm. wide, ovate-lanceolate, acute, densely ciliate, hirsute and glandular on the midvein; corolla-tube slender, slightly curved, densely strigose, 20 mm. long; upper lobe oblong, 5 mm. long, the other lobes broadly semi-ovate, 6 mm. long, 3.5 mm. wide, all cucullate at the apex; anthers elliptic, nearly sessile, minutely appendaged at base; lateral staminodes linear-terete above a flattened base, pubescent, 4 mm. long; central staminode conic-subulate, pubescent, 1.6 mm. long; disk 5-angled, glabrous, 0.6 mm. high, about equaling the ovary; carpels 5, obscurely sulcate down the back; style straight, terete, 8.5 mm. long, densely hirsute with somewhat retrorse hairs.

Slopes of Ridge 25, 5500–6000 ft., *436*.

Our two species find their nearest relative in this small genus in *R. ruellioides* Oliver, an endemic species of Mount Roraima. *R. linearis* is abundantly distinguished by its leaf-shape, its dimensions, and its connate lower lobes of the corolla. *R. Tatei* is much like Oliver's species, but is distinguished by its broader leaves, rounded at base and on shorter petioles, its smaller flowers with glandular sepals, its semi-ovate lobes of the corolla, and its staminodes of unequal length.

SIMARUBACEAE

Lowland species

PICRAMNIA sp. ? A small tree 20 ft. high, in woods at Foothills Camp, Esmeralda, *378*, is apparently an undescribed species of this genus, but its flowers are too immature to permit proper diagnosis.

BURSERACEAE

Lowland species

PROTIUM GUIANENSE (Aubl.) March. A shrub at Fish Creek, Esmeralda, *962;* Tree Savannas at Esmeralda, *319*, *329;* foothills of Mount Duida, 750 ft., *883;* a widely distributed species through northern South America.

PROTIUM PANICULATUM Engl. Middle Camp near Esmeralda, a small tree with white flowers, *348*, *957;* known only from the general region of the Casiquiare River.

TRATTINICKIA BURSERAEFOLIA Mart. Rocky top of Esmeralda Ridge, *210;* highly variable and well distributed through tropical South America.

TRATTINICKIA BURSERAEFOLIA Mart., var. QUINQUEJUGA Engl. Rocky top of Esmeralda Ridge, *195*, *211*. This variety is endemic to Esmeralda, where it was originally collected by Spruce. It probably deserves elevation to specific rank.

MALPIGHIACEAE

Lowland species

BYRSONIMA CHRYSOPHYLLA HBK. Large bushy tree at the edge of high water, Camanaos on the Rio Negro, northern Brazil, *122;* Brazil and Peru, mostly at low altitudes.

BYRSONIMA CRASSIFOLIA (L.) HBK. Rocky top of Esmeralda Ridge, *203;* a common species of wide distribution, ranging from Cuba and Panama to Bolivia and Paraguay.

Heteropterys oblongifolia Gleason, sp. nov. Ramis glabris subteretibus; foliis sessilibus subcoriaceis lineari-oblongis obtusis margine coriaceis basi acutis utrinque glabris et reticulato-venosis; paniculis elongatis tenuissime strigosis bracteis patulis brevibus subacutis obditis; racemis 1–6-floris; sepalis glandulas 8 duplo excedentibus recurvis utrinque dense pubescentibus; petalorum longe unguiculatorum laminis rotundato-ovatis basi truncatis inciso-dentatis; staminibus 10 alternatim paullum inaequalibus basi connatis, antheris arcuatis glabris dorso atro-maculatis; stylis subaequalibus rectis; samarae ala arcuatim adscendente membranacea.

Stems glabrous, subterete, the internodes 1–5 cm. long; leaves sessile, subcoriaceous, linear-oblong, 5–9 cm. long, 1–2 cm. wide, obtuse, coriaceous and

thickened on the margin, acute at base, glabrous, the lower side slightly paler; veins lightly elevated and finely but conspicuously reticulate on both sides; panicles terminal and from the upper axils, slender, 10–15 cm. long, thinly strigose, racemes spreading, the lowest up to 4 cm. long, 1–6-flowered; bracts spreading, oval, subacute, 1–2 mm. long; pedicels 0.4 mm. in diameter, 5–10 mm. long; glands 8, elliptic-oblong, 2 mm. long; sepals revolute, triangular, acute, densely pubescent on both sides, exceeding the glands by 2 mm.; petals with claw 2.7 mm. long, the yellow blade round-ovate above a truncate base, incised-dentate, 3 mm. long and wide; stamens 10, alternately slightly unequal, the filaments flat, narrowly triangular, glabrous, about 2 mm. long, connate for two fifths of their length; anthers broadly oblong, somewhat arcuate, 0.8 mm. long, the connective with a dark purple spot on the back; ovaries ellipsoid-trigonous, 0.9 mm. long; styles nearly straight, slightly divergent, stout, 2.2 mm. long, glabrous, stigmatic at the inner angle of the apex; samaras 15 mm. long, the wing semi-obovate, thickened on the outer margin, 5 mm. wide, rounded above, thinly brown-pubescent, extending down the inner face of the body to a minute obscure basal appendage.

Grand Savanna at Esmeralda, *288*, *297* (type); the former described by the collector as a low woody straggling shrub. This one also differs considerably from the type in the shape of the leaves, the longest being 76 by 29 mm., the broadest 58 by 30 mm.; in correlation with the broader outline they are also rounded at both ends. *H. oblongifolia* is a member of the section *Stenopterys* Nied. and is probably most closely related to *H. Grisebachiana* Nied., which has leaves of a broader outline, pubescent on both sides, and obtuse sepals glabrous within.

LOPHANTHERA LONGIFOLIA (HBK.) Griseb. River banks and flood sands, Muyrapenima, on the Rio Negro, northern Brazil, *53;* distributed through the valley of the Amazon and also reported from southern Brazil.

Species of Mount Duida

BYRSONIMA BRACTEOLARIS Benth. A low bushy tree or shrub with pink flowers, on hillsides at Central Camp, 4800 ft., *566*, *595;* dry crests of Savanna Hills, 4400 ft., *740*. The species has been known only from Schomburgk's original collections near or on Mount Roraima, with which our specimens agree precisely.

Byrsonima cretacea Gleason, sp. nov. Fruticosa; ramis novellis dense brunneo-tomentosis; petiolis brevibus crassis; stipulis ovatis acuminatis erectis; foliorum laminis coriaceis ovato-oblongis apice rotundatis basi cordatis amplexicaulibus supra glabris subnitentibus subtus indumento albido cretaceo obtectis; racemis brevibus et pedunculis pedicellisque dense tomentosis; calyce 10-glanduloso sepalis triangulari-ovatis recurvatis extus tomentosis; filamentis glabris teretibus; connectivo non producto verruculoso; thecis basi breviter

productis apice introrse barbatis ceterum glabris; ovario glabro; stylis subulatis.

"A straggling tree" (Tate); branches of the season stout, densely tomentose with purple-brown matted hairs, those of the second season nearly or quite glabrous, the internodes 4–7 cm. long; stipules intrapetiolar, broadly triangular-ovate, erect, 5–6 mm. long, sharply acute, densely tomentose on the back; petioles very stout, 3–4 mm. long, densely tomentose on the back, apparently glandular on the sides; blades coriaceous, ovate-oblong, the lowest of each season's growth 30 by 17–25 mm., the upper gradually larger to as much as 73 by 54 mm., broadly rounded and sometimes minutely apiculate at the summit, entire, deeply cordate at base, the rounded auricles 8–11 mm. long; lateral nerves about 15 pairs, ascending at about 70°, essentially plane and finely reticulate above; upper surface dark green, somewhat shining, glabrous; lower surface completely covered with a dense white chalky separable indument; inflorescence of 1 or 2 crowded terminal racemes 6–8 cm. long, of which the basal 2 cm. is sterile, densely red-brown tomentose, its branches jointed near the base, above which the pedicel is as much as 16 mm. long; bracts deciduous, lanceolate, long-acuminate, subcordate and sessile at base, glabrous above, densely tomentose beneath; sepals connate for about two fifths of their length and bearing 10 obovate glands 2.8 mm. long, the free tips exceeding the glands by 3.2 mm., strongly recurved at tip, acute, fleshy, glabrous within, tomentose without; petals broadly ovate, slightly erose, rounded at the summit, rounded below to a somewhat decurrent base, 6.5 mm. long, 5.5 mm. wide, on claws 2.3 mm. long, the fifth petal slightly larger with a stouter clavate claw; filaments 3.7 mm. long, glabrous, red; connective stout, brown, semiterete, 1.3 mm. long, rounded on the back and at the summit, minutely verruculose, minutely exceeding the thecae; thecae 1.4 mm. long, prolonged at base 0.2 mm., contiguous and somewhat widened upward, pilose at the tip with 6–8 stiff introrse hairs 0.6–0.8 mm. long; ovary subglobose, glabrous; styles terete, sharp, straight, slightly divergent, 4 mm. long; receptacle densely brown-tomentose within (Pl. 28, fig. 2).

Hillsides and flat ground at Central Camp, 4800 ft., *533*. The collector notes that the petals are white and the leaves "peppered with brown" beneath; this appearance proves to be caused by the copious growth of an alga. The position of the species in the genus is clearly in subgenus *Brachyzeugma*, section *Eriolepis*, subsection *Brachypus*, series *Brachybotrys*, where it is obviously related to *Byrsonima variabilis* Juss. Its distinguishing features are the larger flowers, the smaller anthers, the deeply cordate leaves, and especially the continuous chalky coating of the lower surface of the leaves.[1]

[1] A common, straggly, small tree with long weak ascending branches. It is widely distributed in the slope forest and brush, being also equally common at Provisional Camp and among the *Tyleria* woods at Central Camp.—G. H. H. T.

DIACIDIA VESTITA (Benth.) Jackson. A slender tree 20 ft. high, with yellow flowers, the persistent calyx enlarging and turning red at maturity of the fruit, stream-bank at Central Camp, alt. 4800 ft., *563.* This well marked species, neglected by recent authors, has been known only from the original collection of Schomburgk in the region of Mount Roraima.[1]

VOCHYSIACEAE[2]

Lowland species

Qualea esmeraldae Standl. sp. nov. Ramuli crassi fusci glabri, internodis brevibus; folia brevissime petiolata crasse coriacea opposita, laminae marginatae oblongae vel ovali-oblongae apice rotundatae vel emarginatae et mucronatae, basi rotundatae, glabrae, venis creberrime gracillimis; inflorescentia pauciflora, ciciniis 1–2-floris, floribus magnis breviter pedicellatis, alabastris elongato-oblongis acutiusculis, calcare pedicello paullo breviore cylindrico c. quartam calycis partem metiente; anthera dense barbata; capsula ellipsoidea glabrata rotundato-trigona apice acuta et in stylum elongatum sensim attenuata.

Branchlets stout, fuscous, glabrous, subterete, the internodes 1.5–2.5 cm. long; leaves thick-coriaceous, very shortly petiolate, opposite, the thick petioles 4–7 mm. long, glabrous; leaf-blades glabrous, oblong to oval-oblong, 7–9.5 cm. long, 3.5–5 cm. wide, broadly rounded or shallowly emarginate at the apex, rounded at the base, conspicuously marginate, yellowish-green on the upper surface, the venation prominulous, brownish and much paler beneath, the costa stout, prominent, the veins very numerous and approximate, diverging at nearly a right angle, united to form a distinct and regular collective nerve less than 1 mm. from the margin; inflorescence terminal, simply racemose, 4–11 cm. long, rather few-flowered, the rachis angulate, minutely ferruginous-puberulent, the internodes 1 cm. long or less, the flowers solitary or geminate, the stout pedicels 4–5 mm. long, sparsely puberulent; bractlets at the base of the pedicel minute; calyx-segments coriaceous, ciliate, the outer ones broadly ovate, acute, 3 mm. long, the third and fifth broader and twice as long, the blade of the fourth broadly elliptic, carinate, 18 mm. long, obtuse, sparsely ferruginous-puberulent, the spur 5 mm. long, cylindric, obtuse; petal suborbicular, 2 cm. long, glabrous, with numerous short broad crispate lobes near the apex; filament very thick, glabrous, 8 mm. long, the anther 1 cm. long, densely barbate along one side; style stout, about 2 cm. long, glabrous; ovary ferruginous-hirsute; capsule ellipsoid, rounded-trigonous in cross section, 2.5 cm. long, glabrate, densely and minutely tuberculate, obtuse at the base, acute at the apex and gradually narrowed to the base of the persistent style.

[1] This plant, a good-sized tree with straight trunk six to eight inches in diameter, was first observed along the stream a short way below Central Camp. Here it was rather common.—G. H. H. T.

[2] By Paul C. Standley.

Rocky top of Esmeralda Ridge, *194*. It is evident that this plant is related to *Q. cassiquiarensis* Spruce, of the same general region, but it disagrees in so many respects with the description of that species that it does not seem possible that it can be conspecific. The leaves of *Q. cassiquiarensis* are described as much larger, the flowers considerably larger, and the spur of the calyx as conic.

Species of Mount Duida

QUALEA sp. Agüita, 4000 ft., *915*. The specimen is sterile and it has not been possible to place it specifically. Probably it represents an undescribed species. The leaves are rather narrowly oblong and acute.

POLYGALACEAE[1]

Lowland species

ELSOTA DIVERSIFOLIA (L.) Blake. Rocky top of Esmeralda ridge, *212*. Common from northern Mexico to Ecuador, and from the Lesser Antilles to Brazil. Tate's plant somewhat approaches *E. coriacea* (Bonpl.) Blake, a rather doubtfully distinct species.

POLYGALA ADENOPHORA DC. Esmeralda, *178*, *280*. British Honduras; Trinidad and Venezuela to French Guiana.

POLYGALA HYGROPHILA HBK. Dry savannas, Esmeralda, *257*. British Honduras; Panama to northern South America.

Species of Mount Duida

Monnina duidae Blake, sp. nov. Frutex, ramis parce patenti-hirsutulis; folia ovalia vel obovato-ovalia ca. 3 cm. longa 1.5 cm. lata petiolata estipulata apice rotundata obtuse apiculata vel emarginata basi rotundato-cuneata coriacea marginata margine vix revolute utrinque strigillosa; racemi 3 breves terminales; flores mediocres; sepala inferiora per tertiam partem longitudinis connata; ovarium glabrum.

Shrub ca. 0.6 m. high; branches 1.5–2 mm. thick, not densely spreading-hirsutulous and often sparsely strigillose; internodes 2–7 mm. long; petioles strigillose and sparsely hirsutulous, 2–3 mm. long, narrowly margined above; blades 2–3.3 cm. long, 1.3–1.8 cm. wide, with paler slightly thickened scarcely revolute margin, glabrescent above, sometimes sparsely hirsutulous on costa beneath, penninerved, the costa prominent and the about 3 pairs of principal lateral veins prominulous beneath, the veins and costa sulcate above, the secondaries inconspicuous; racemes pubescent like the stem, the peduncles about 5 mm. long, the racemes rather dense, about 6 mm. long, 8–10 mm. thick (as pressed), the axis becoming 3 cm. long; bracts caducous, not seen; pedicels strigillose, 1 mm. long; "flowers purple and yellow"; upper sepal oblong-ovate,

[1] By S. F. Blake.

obtuse, ciliolate, 2 mm. long; lower sepals ovate, obtuse, ciliolate, 1.5 mm. long; wings obovate-suborbicular, 4.5 mm. long, 3.8 mm. wide, 4-nerved, ciliate on the short claw and at base of limb; keel 5 mm. long, ciliolate on upper margin for about half its length from base; upper petals obliquely ov· te, 4 mm. long, somewhat dilated and bent at tip, densely puberulous on upper margin for about two thirds of their length, the free part pilose near the middle on both surfaces; stamens 8, the sheath pilose on margin, long-pilose at tip, the filaments glabrous, 1–1.5 mm. long; ovary and style glabrous; fruit not seen.

Summit of Peak 7, 7100 ft., *604*. Apparently nearest *M. cacumina* N. E.Br. of Mt. Roraima, which from description has glabrous or very sparsely short-pubescent branches, larger oblong or lance-oblong glabrous leaves (5 cm. long and 2.5 cm. wide), and upper petals with different pubescence.

EUPHORBIACEAE

Lowland species

APARISTHMIUM CORDATUM (Juss.) Baill. Along the Rio Negro at Santa Isabel, *977*, *988*, *989;* as new growth in burned forest at Esmeralda, *343*. The species ranges from Venezuela and the Guianas south to southern Brazil and Bolivia.

CROTON CUNEATUS Klotzsch. At Yucabí, on the Rio Negro, northern Brazil, *971*, *991;* upper Amazonian forests and the Guianas.

CROTON PALANOSTIGMA Klotzsch. Santa Isabel on the Rio Negro, *984;* a native of the Amazonian region.

CROTON SUAVIS HBK. River banks and flood sands at Muyrapenima, on the Rio Negro, northern Brazil, *66*, *68;* British Guiana and coastal Venezuela.

MAPROUNEA GUYANENSIS Aubl. On land subject to flood at Muyrapenima and Camanaos, on the Rio Negro, northern Brazil, *62*, *121*. The species is widely distributed from the Guianas south to Bolivia and southern Brazil.

PHYLLANTHUS DIFFUSUS Klotzsch. East Swamp at Esmeralda, *261;* a common species through the West Indies and tropical South America.

POGONOPHORA SCHOMBURGKIANA Miers. Santa Isabel, on the Rio Negro, northern Brazil, *990*. The species ranges from the Guianas and the upper Amazon valley south to Rio de Janeiro.

Species of Mount Duida

Phyllanthus duidae Gleason, sp. nov. Fruticosa ramosa, ramis glabris superne glaucescentibus; petiolo brevissimo; foliorum laminis subcoriaceis late rotundis integris, apice rotundatis vel subretusis, basi alte cordatis caulem amplectentibus, glabris pallide viridibus; perianthio 6-partito sepalibus

femineis valvatis, masculinis imbricatis; staminibus 3 liberis; filamentis brevissimis, antheris extrorsis longitudinaliter dehiscentibus; disco et ovarii rudimento nullo; capsula 6-valvata 3-loculare 6-sperma, calyce indurato persistente.

A branching shrub at least 3 dm. high, the branches slightly glaucous when young, glabrous, terete, with internodes 5–10 mm. long; petioles stout, 1 mm. long; leaf-blades subcoriaceous, pale green, broadly rotund, as much as 25 mm. long by 30 mm. broad, entire, rounded or obscurely retuse at the summit, deeply cordate and amplexicaul at the base, with rounded auricles and narrow sinus, glabrous, the veins obscure above, evident and lightly impressed beneath, subdichotomous and scarcely reticulate; staminate flowers in small clusters: sepals 6, in two circles of 3, thickened below the middle, elliptic-oblong, the outer 2.4 by 1.3 mm., the inner 2.1 by 0.9 mm.; disk and rudiment of ovary none; stamens 3, free, extrorse, the very short filaments widened above to a triangular connective slightly exceeding the oblong pollen-sacs which are contiguous above and divergent below; pistillate flowers solitary, the pedicel at maturity 5 mm. long and thickened distally; sepals 6, valvate, persistent, eventually 10 mm. long by 2.5–3 mm. wide; disk represented by 6 rounded lobes within and opposite the sepals; capsule globose, 5 mm. long, 3-celled, 6-seeded, the united portion of the persistent styles 4 mm. long (Pl. 29).

Summit of Peak 7, 7100 ft., *629* (type), *640;* on dryish outcrop, Ridge 23a, 6400 ft., *479*. The characters enumerated above indicate that it belongs to the section *Microglochidion* Muell. Arg., hitherto represented by two species of Mount Roraima. The Duida plants differ from them in their remarkably broad, deeply cordate, clasping leaves.[1]

PHYLLANTHUS VACCINIIFOLIUS Muell. Arg. A bush 6 ft. high on the slopes of Ridge 25, 5500–6000 ft., *447*. The leaves are nearly or quite twice as large as those of specimens from Mount Roraima, which is the only previously known station for the species.

CYRILLACEAE

Species of Mount Duida

CYRILLA BREVIFOLIA N. E. Brown. Summit of Peak 7, 7100 ft., *1045;* known elsewhere only from Mount Roraima. The differences between this and the following species are slight and scarcely entitle it to specific rank.

CYRILLA RACEMIFLORA L. Slopes of Ridge 25, 5500–6000 ft., *419;* a bush 10 ft. high at Desfiladero, 6100 ft., *693;* summit of Peak 7, 7100 ft.,

[1] This low-growing, wiry little plant was first noted on Ridge 23b at a place where the soil was very thin and instead of sandstone a thick bed of shale was exposed. Later it was seen to be plentiful on the top of Peak 7 and on the crests of most of the ridges near the cliffs.—G. H. H. T.

615; without locality, *1015*. The species extends from the southeastern United States through the West Indies into northern South America.

PURDIAEA NUTANS Planch. Slopes of Ridge 25, 5500–6000 ft., *425;* summit of Peak 7, 7100 ft., *611;* hitherto believed endemic to the mountains of northeastern Colombia.

AQUIFOLIACEAE

Species of Mount Duida

Ilex duidae Gleason, sp. nov. Fruticosa glaberrima; petiolis brevibus crassis rugosis; laminis coriaceis nitentibus late ellipticis vel subobovato-oblongis, minute apiculatis integris subrevolutis basi rotundatis subtus punctatis; venis lateralibus paullum adscendentibus leviter elevatis; paniculis masculis axillaribus ramosis bracteis minutis late subulatis; pedicellis flores aequantibus vel sublongioribus; petalis late ovatis crassis insigniter reticulatis; filamentis latis antheras aequantibus; antheris cordato-ovatis loculis discretis; ovario ovoideo 5-loculare, stylo nullo.

A bushy shrub, glabrous throughout, the internodes 15–30 mm. long; petioles stout and thick, rugose, 3 mm. long; blades coriaceous, shining above, brown and opaque beneath, 5–8 cm. long, 3.5–5.5 cm. wide, broadly elliptic or subobovate-oblong, broadly rounded above to a minutely apiculate tip, revolute, rounded at base; lateral veins ascending at an angle of about 75°, lightly elevated on both sides, the veinlets obscure and reticulate; stipules none; panicles axillary, freely branched, two-thirds as long as the subtending leaves, the minute bracts broadly subulate; pedicels 2–4 mm. long; calyx-lobes depressed-ovate to nearly semicircular, thick in the middle, thinner at the margins, rounded, obtuse, or subacute at the apex; petals spreading, broadly ovate, rather fleshy, 2.7 mm. long, 1.9 mm. wide, rounded above, conspicuously reticulate; stamens 5, alternate with the petals, inserted at the summit of the short corolla-tube; filaments flattened, 0.8 mm. long, 0.4 mm. wide, erect; anthers cordate-ovate, 0.8 mm. long, the two thecae separate and opening by lateral longitudinal slits; ovary 5-celled, stoutly ovoid, 1.7 mm. high; style none, the sessile stigma 1.5 mm. in diameter, obscurely lobed.

Ridge crest at Savanna Hills, 4400 ft., flowers white, *772*. The species is most closely related to the Andean *I. obtusata* (Turcz.) Triana, which differs in its striate petiole, pubescent calyx, and various other characters.

ILEX RETUSA Klotzsch. A bush 10 ft. high, with thick leaves and red fruit, moist slopes of the Savanna Hills, 4400 ft., *728, 833;* also known from Mount Roraima.

ILEX RETUSA Klotzsch, var. SUBEPUNCTATA Loes. A bush 6 ft. high, with white flowers, slopes of Ridge 25, 5500–6000 ft., *449;* summit of Peak 7, 7100 ft., *619, 643;* also known from Mount Roraima. If our material is

sufficient to give a proper idea of the distribution of both species and variety, the latter is evidently the form of higher altitudes.

ILEX sp. A shrub or tree at Central Camp. 4800 ft., *557*. It has solitary axillary fruits and coriaceous, obovate-oblong, conspicuously crenate leaves 7–10 cm. long.

ILEX sp. A shrub 3 ft. high on the slopes of Ridge 25, 5500–6000 ft., *424*. The coriaceous leaves are oblong, acute to retuse, 3–4 cm. long and half as wide; the fruits are axillary, solitary, and long-pedicelled.

ILEX sp. A bush from the summit of Ridge 25, 6000 ft., *526*, has been referred tentatively to this genus. The coriaceous leaves are spatulate-oblong, tapering to the base, rounded and minutely apiculate at the summit.

HIPPOCRATEACEAE

Species of Mount Duida

HIPPOCRATEA sp. A sterile specimen of a vine from the canyon of the Rio Negro, 4400 ft., *827*, is undoubtedly of this genus, but it is impossible to carry the identification further with assurance.

ICACINACEAE

Lowland species

Poraresia Gleason, gen. nov.

Frutex vel arbor foliis amplis alternis petiolatis, paniculis parvis axillaribus, floribus sessilibus bracteis 3 suffultis. Sepala 5 libera valde imbricata. Petala 5 lineari-oblonga supra medium incrassata villosa. Stamina 5 cum petalis alternis hypogyna. Filamenta filiformia supra medium villosa. Anthera linearia 4-locellata longitudinaliter dehiscentia connectivo non superata. Ovarium obpyramidatum glabrum. Styli 2 hirsuti, stigmate non incrassato.

Stems woody. Leaves alternate, ample, long-petioled. Stipules none. Panicles small, axillary, few-flowered. Flowers 5-merous, sessile, each closely subtended by 3 bractlets. Calyx strongly imbricate, the outer two sepals shorter than the others, the inner two considerably widened. Petals imbricate, linear-oblong, the basal half thin, the distal half thickened, more or less involute, and densely villous within. Stamens 5, alternate with the petals. Filaments filiform, elongate, densely villous in the distal half. Anthers linear, 4-celled, the thecae attached laterally to the connective, dehiscent in two longitudinal slits, not surpassed by the connective. Ovary glabrous, obpyramidal. Styles 2, elongate, hirsute, the stigma not differentiated.

The name is compounded from *Poraqueiba* and *Villaresia*, two genera of the *Icacinaceae* which our plant resembles in some features.

Poraresia anomala Gleason, sp. nov. Caule glabro multi-sulcato; foliis longe petiolatis elliptico-oblongis abrupte acuminatis integris basi acutis

utrinque glabris, venis lateralibus utrinque prominentibus adscendentibus; paniculis petiolos aequantibus vel duplo longioribus arcte sericeis; bracteis calyce brevioribus late triangularibus ciliatis; sepalis extimis late ovatis intimis latissimis, petalis extus pulverulentis.

Stem smooth, about 10-sulcate, the internodes slender, 2–5 cm. long; petioles slender, 2–3 cm. long, flattened on the top with elevated margins, very minutely pubescent; leaf-blades thin, obovate-oblong, 15–19 cm. long, 5–8.5 cm. wide, abruptly acuminate, entire, broadly acute at base, glabrous throughout, midvein and lateral veins (6–11 on each side) prominent on both sides; panicles 3–5 cm. long, minutely sericeous; bractlets broadly triangular, 0.7 mm. long, ciliate; flowers sessile; sepals broadly ovate to depressed-rotund, 1.6–1.8 mm. long, 1.3–2.2 mm. wide, depending on their position, all glabrous; petals 4 mm. long, the basal 1.6 mm. thin in texture and obscurely 3-nerved, the distal 2.4 mm. thick or subfleshy, usually involute, and densely villous on its lower half with white hairs 1 mm. long or more; filaments filiform, 2.4 mm. long, densely villous above the middle; anthers 1.9 mm. long; styles about 1.9 mm. long, one always exceeding the other.

At Santa Isabel, northern Brazil, *979*. The taxonomic position of this plant has been a matter of some difficulty, especially since it was not possible to determine the structure of the ovary satisfactorily. The bearded petals, the filaments villous toward the summit, the anthers with their lateral thecae are all common characters among members of the *Icacinaceae*, suggesting respectively *Poraqueiba*, *Kummeria*, and *Emmotum;* the venation of the leaf is almost precisely that of *Poraqueiba*. Separate sepals are characteristic of *Villaresia*, a genus with short, cordate-reniform anthers, while the other American genera have a tubular calyx with the sepals reduced to small lobes. No record has been found of any American genus possessing anthers so long and so proportionately slender as those of our plant, and the presence of two styles, which seems to be universal, is an exception among other members of the family.

Species of Mount Duida

Emmotum argenteum Gleason, sp. nov. Ramis dense cinereis; petiolis brevibus cinereis; foliis juvenilibus argenteo-sericeis, adultis oblongis acuminatis basi rotundatis utrinque ad venam sericeis ceterum mox glabrescentibus venis lateralibus venulisque obsoletis; fasciculis axillaribus brevibus sessilibus paucifloris; floribus subsessilibus; calyce 5-mero sericeo lobis triangularibus acutis tubam aequantibus; petalis ovato-lanceolatis intus supra medium ad venam villosis; filamentis complanatis ad basin dilatatis; antheris triangulari-ovatis acutis, thecis lateralibus apice approximatis connectivo non superatis; ovario villoso 3-loculari; stylo breve apice 3-dentato.

Branches nearly terete, densely sericeous when young, eventually glabrous, the internodes 2–3 cm. long; petioles channeled above, densely serice-

ous, 5–8 mm. long; blades firm or subcoriaceous in texture, dull green, oblong, 7–12 cm. long, 32–47 mm. wide, abruptly acuminate into a very sharp cusp 12–15 mm. long, entire, rounded or broadly obtuse at base, densely silvery-sericeous when young, permanently sericeous on the midvein, otherwise soon becoming glabrous, the lateral veins and veinlets obscure or almost obsolete; fascicles axillary, few-flowered, about equaling the petioles, sericeous; flowers subsessile; calyx-tube deeply saucer-shape, 1.2 mm. long, the lobes triangular, acute, 1.2 mm. long, the whole finely sericeous; petals firm in texture, ovate-lanceolate, 3.3 mm. long by 1.4 mm. wide, sharply acute, slightly outwardly curved, sericeous on the outside, the inner side nearly glabrous below, above the middle near the midvein densely villous with reddish-yellow hairs; filaments 2.8 mm. long, glabrous, dilated toward the base; anthers triangular-ovate, 0.9 mm. long, acute, the thecae attached laterally, separate below, approximate at the summit; ovary globose-ovoid, 1.5 mm. long, densely sericeous; style straight, 0.8 mm. long, 3-toothed at the summit.

On slopes at Central Camp, 4800 ft., *564*, described by the collector as a small slender shrub. It is most nearly related to *E. fagifolium* Desv., but differs in its acute anthers, its almost obsolete veins and veinlets, its almost glabrous mature leaves, and its much more densely sericeous stem. Of these the lack of conspicuous lateral veins is most obvious and sets it apart at once from all other species of the genus.

SAPINDACEAE

Lowland species

Cardiospermum Halicacabum L. San Carlos on the Rio Negro, northern Brazil, *163;* widely distributed throughout tropical America.

Two sterile specimens of trees from Esmeralda, *309*, *353*, may belong in this family but have not been satisfactorily referred to a genus.

VITACEAE

Lowland species

Cissus erosa L. C. Rich. River banks and flood sands at Muyrapenima, on the Rio Negro, northern Brazil, *57*. The species ranges from Central America and the West Indies south to Brazil.

Cissus sicyoides L. San Carlos, on the Rio Negro, northern Brazil, *161;* widely distributed from Florida and Mexico to Brazil.

MALVACEAE

Lowland species

Hibiscus furcellatus Lam. River banks and flood sands at Muyrapenima, on the Rio Negro in northern Brazil, *55*, *71*. Widely distributed through the American tropics from Florida and Mexico to Paraguay.

SIDA GLOMERATA Cav. In second growth, Santa Isabel, northern Brazil, *91*. Common from the West Indies and Central America to Bolivia.

STERCULIACEAE

Lowland species

BUETTNERIA JACULIFOLIA Pohl. Swampy savanna at Esmeralda, *186*. It is a characteristic species of the savannas north of the Amazon, and ranges from eastern Colombia to British Guiana.

DILLENIACEAE

Lowland species

DAVILLA ASPERA (Aubl.) Benoist. New Savanna, Esmeralda, *345;* a common species from Venezuela and the Guianas to Bolivia and southern Brazil.

DOLIOCARPUS DENSIFLORUS Sprague & Williams *ined.* A shrub in swampy ground, Grand Savanna, Esmeralda, *282;* also at Middle Camp, Esmeralda, *346;* hitherto known only through the type collection of Spruce from Tarapoto, Peru. It is with regret that an unpublished name is used in this report.

OCHNACEAE

Lowland species

OURATEA RORAIMAE Engl. Tall bush at base of Esmeralda Ridge, *276*. The species is otherwise known only from much greater altitudes in the vicinity of Mount Roraima.

OURATEA SPRUCEANA Engl. Rocky top of Esmeralda Ridge, *192*, a shrub with red capsules; Buena Vista, on the Rio Casiquiare, *154;* the only other known collection is from San Carlos.

OURATEA VERRUCULOSA Engl. A shrub at San Gabriel, on the Rio Negro, northern Brazil, the only known station of the species.

Pentaspatella Gleason, gen. nov.

Folia parva margine incrassata venulis adscendentibus. Stipulae ad pila brevia reductae mox deciduae. Flores parvi 5-meri. Sepala imbricata venis parallelis. Petala obovata. Staminodia parva spathulata inter filamenta inserta et eis brevioria. Filamenta brevia crassa. Antherae subulatae apiculatae. Ovarium ovoideum apice obtusum 1-loculare ovulis paucis basalibus. Stylus filiformis. Stigma punctiforme. Capsula 3-valvata.

Herbaceous, freely branched above. Leaves small, thickened at the margin, with ascending, somewhat branched veinlets. Stipules reduced to slender hairs, soon deciduous. Inflorescence paniculate, terminal, many-flowered. Flowers pedicelled, 5-merous. Sepals imbricate, with parallel veins. Petals

obovate. Staminodes 5, spatulate, shorter than the stamens and inserted between them, forming with them a single continuous ring. Filaments short and stout. Anthers subulate, apiculate. Ovary ovoid, obtuse at the summit, 1-celled, the ovules few, borne on long funiculi from the base. Style filiform straight. Stigma punctiform. Capsule 3-valved.

Although the single species has the aspect of *Sauvagesia*, it differs greatly in the character of its staminodes and ovary and is clearly related to *Leitgebia*, from which it is distinguished by its stipules and inflorescence, as well as by its general habit.

The name of the genus refers to its five spatulate staminodia.

Pentaspatella ramosa Gleason, sp. nov. Herba ramosa; caule angulato folioso, stipulis subulatis deciduis, foliis anguste ellipticis obtusis integris subrevolutis ad petiolum brevissimum angustatis; panicula multiflora, pedicellis brevibus gracilibus; sepalis ovato-lanceolatis obtusis; petalis obovatis; staminodiis staminibus et pistillo ut supra descriptis.

A freely branched herb 4–8 dm. tall; stems simple below, strongly angled, persistently leafy; stipules subulate, 3 mm. long; petioles scarcely differentiated, 1 mm. long or less; blades narrowly elliptic, 2–3 cm. long, 5–9 mm. wide, obtuse, entire, somewhat revolute, at least when dried, acute at base, glabrous, dull green, the lateral veinlets obscure; panicles terminal, 3–6 cm. long, many-flowered; pedicels slender, 3–5 mm. long; sepals ovate-lanceolate, 4 mm. long, obtuse, parallel-veined; petals obovate, apparently about 5 mm. long; staminodes 5, between the stamens, spatulate, flat, acute, 1.3 mm. long; filaments stout, about 0.2 mm. long; anthers subulate, 2.4 mm. long, tapering to the apiculate apex; ovary about 1.5 mm. long, ovoid, obtuse, 1-celled, bearing several basal ovules on long funiculi; style very slender, 2.5 mm. long.

Grand Savanna at Esmeralda, *292*, *1005* (type).

SAUVAGESIA DEFLEXIFOLIA Gardn. East Swamp at Esmeralda, *265;* also in Goyaz, central Brazil.

Species of Mount Duida

LEITGEBIA GUIANENSIS Eichl. Gorge of Caño Negro, Savanna Hills, 4000 ft., *807;* a straggling bush on the Savanna Hills, 4400 ft., *751;* a low woody bush on Ridge 23c, 6500 ft., *662*. In these three specimens the leaves are only 6–10 mm. long. A fourth specimen, a brittle-stemmed shrub 3 ft. high on the Brocchinia Hills, 4500 ft., *590*, has leaves as much as 22 mm. long; being sterile it is referred here with some doubt. The species has been known hitherto only from the region of Mount Roraima.

Luxemburgia duidae Gleason, sp. nov. Ramis angulatis stipulis persistentibus; foliis coriaceis anguste oblanceolatis acutis remote incurvo-

denticulatis basi longe cuneatis; floribus paucis solitariis in axillis foliorum superiorum longe pedunculatis; pedunculis medio articulatis; sepalis rotundatis obtusis interioribus majoribus; petalis obovatis rotundatis basi cuneatis; staminibus 25, antheris sessilibus conniventibus; ovario excentrico obliquo triquetro superne in stylum acuminato.

A shrub 18 dm. high with yellow flowers; branches sharply angled, the internodes 1–3 mm. long, leafless below and roughened with elevated leaf-scars and persistent stipules; leaves crowded toward the summit of the branches; stipules narrowly triangular, 3–4 mm. long, deeply fringed; blades bright green, coriaceous, shining, narrowly oblanceolate, 6–11 cm. long, 8–14 mm. wide, acute, long-cuneate at base into an indefinite petiole, the margins strongly thickened and conspicuously denticulate with curved appressed teeth 0.5 mm. long and 2–4 mm. apart, midvein prominent and elevated on both sides, lateral veins numerous, ascending at an angle of about 50°, impressed above, slightly elevated beneath; peduncles few, solitary in the upper axils, 3–4 cm. long, jointed near the middle, with a minute triangular bractlet below the joint; sepals 5, imbricate, broadly rotund, varying in size from the outermost 4 mm. long to the innermost 7.5 mm. long; petals obovate, 15 mm. long, 10 mm. wide, rounded above, cuneate at base; anthers 25, sessile, linear, tetragonal, 7 mm. long, opening by two apical pores, all connivent into an erect mass in the center of the flower; ovary fusiform, 3-angled, 11 mm. long, inserted excentrically and laterally on the short androphore, tapering above to the indefinite style; capsule fusiform, 3-angled, 2 cm. long (Pl. 31, fig. 1).

At Central Camp, 4800 ft., *529* (type), *1031*. All its characters indicate that it is closely related to *L. speciosa* St. Hil. and *L. angustifolia* Planch. Its leaves are proportionately narrower than in the first of these and broader than in the second, and are actually longer than either. Its one-flowered peduncles are distinctive, both of the others bearing a raceme.

Luxemburgia longifolia Gleason, sp. nov. Ramis angulatis, stipulis minimis ovatis breviter ciliatis; foliis crassis nitentibus lineari-oblanceolatis elongatis acutis remote incurvo-denticulatis basi longe cuneatis; inflorescentia racemosa multiflora pedicellis gracilibus ad basin articulatis et bracteolatis; capsula fusiforme triangulare acuminata.

Stems woody, the branches angular, roughened with broadly elliptic leaf-scars and persistent stipules, the internodes 3–10 mm. long; stipules triangular-ovate, appressed, 2–3 mm. long, short-ciliate; leaf-blades coriaceous, bright green and shining, linear-oblanceolate, 15–25 cm. long when mature, often falcate, acute, cuneate to the sessile base, conspicuously denticulate with incurved teeth 0.5 mm. long and 3–7 mm. apart, veins elevated on both sides, the veinlets ascending at an angle of about 70°; inflorescence a terminal raceme 12 cm. long; pedicels slender, 20–25 mm. long, articulated and bracteolate near the base; capsule falcate, fusiform, acuminate, 22 mm. long.

On Agüita Slope, 4000 ft., *1032*. Although the flowers are absent, the persistent androphore leaves no doubt of its genus and its general habit and the character of its leaves show its affinity with *L. duidae* Gl., *L. speciosa* St. Hil., and *L. angustifolia* Planch. It differs from all of these in the shape of its stipules, as well as in its greatly elongate leaves.

The preceding two species are apparently the only representatives of the genus north of the Amazon.

Ouratea sp. A bush on ridge crests, Savanna Hills, 4400 ft., *771*. While there is no doubt that it represents an undescribed species, the publication of a name has been deferred for lack of mature flowers.

Tyleria Gleason, gen. nov.

Folia ampla venis longitudinalibus vel transversis parallelis. Stipulae breves adpressae integrae. Flores magni 5-meri. Sepala imbricata venis parallelis. Petala obovata rosea vel alba. Staminodia 5 vel 10 uniseriata basi connata in tubum brevem ovarium amplectentem; quorum 5 ad stamina opposita brevioria explanata sunt vel nulla. Stamina 5; filamentis nullis; antheris subulatis erectis. Ovarium conicum 3-loculare in stylum subulatum angustatum, ovulis in quoque locello multis.

Leaves ample, sessile or nearly so, not thickened at the margin, with very numerous fine parallel veins, either parallel to the midvein or ascending. Stipules triangular, broader than long, deciduous, entire. Flowers 5-merous. Sepals imbricate, finely parallel-veined. Petals obovate, white to pink, large and conspicuous. Staminodes in a single series, connate at base into a short cup surrounding the base of the stamens, the five alternate with the stamens erect, spatulate, membranous, petaloid, involute, surpassing the anthers, those opposite the stamens smaller or none. Stamens 5, the anthers stoutly subulate, sessile, minutely apiculate. Ovary conic, 3-celled, many-ovuled, tapering gradually into the elongate style; stigma punctiform.

The genus commemorates in its name Mr. Sidney F. Tyler, financial sponsor and member of the Tyler-Duida Expedition.

The nearest affinity of *Tyleria* is apparently with *Leitgebia Imthurniana* Oliver, from which it differs in its deciduous entire stipules, in the venation of the leaves and the absence of a marginal thickening, in the presence of some sort of accessory staminodes, and in general size and habit. Its relation is evidenced by the position of the staminodial tube on the outside of and free from the stamens, with its erect, spatulate, petaloid segments. *Tyleria* begins its scientific history with four species, at least two of which become large trees, and all of which have a profusion of beautiful flowers which must make them remarkably handsome plants

when in bloom.[1] *T. floribunda* is designated as the nomenclatorial type of the genus. The species may be separated according to their more obvious characters by the following key, but may be distinguished equally well by the character of the staminodes, as particularly described under each one.

Leaves parallel-veined from base to apex.
  Flowers numerous, on short pedicels in large terminal panicles — *T. floribunda.*
  Flowers solitary and axillary among the upper leaves.
    Leaves elliptic-oblong, 1 cm. wide or more; petals 30 mm. long — *T. grandiflora.*
    Leaves linear, 5 mm. wide or less; petals 20 mm. long — *T. linearis.*
Leaves parallel-veined from midrib to margin; flowers in terminal racemes or narrow panicles — *T. spathulata.*

Tyleria floribunda Gleason, sp. nov. Arborescens; stipulis parvis latis arcte adpressis mox deciduis; foliis sessilibus rigidis coriaceis glabris elliptico-linearibus obtusis ad marginem scabridulis; floribus paniculatis pedicellatis; sepalis ovato-lanceolatis; petalis obovatis; staminodiorum segmentis basi lobis 2 subulatis brevibus munitis.

A large tree; branches stout, permanently marked with elliptic leaf-scars, the internodes about 3 mm. long; leaves sessile, rigid, coriaceous, very narrowly elliptic, 8–11 cm. long, 18–23 mm. wide, obtuse, minutely scabrid on the margin, barely narrowed to the broad base, glabrous and shining, with very numerous fine veins; panicle terminal, erect, freely branched, many-flowered, 10–15 cm. long, its glabrous branches angular and slightly bent at each node; pedicels slender, 5–8 mm. long; sepals ovate-lanceolate, 10 mm. long, 4 mm. wide when flattened, acute; petals "cherry-pink," obovate above a cuneate base, 15 mm. long, 9 mm. wide; staminodes connate for somewhat more than 1 mm. at base, the spatulate petaloid segments about 8 mm. long, separated by rounded sinuses, rounded at the summit, 0.8 mm. wide at base, 1.7 mm. wide near the summit, each with a pair of flat, subulate, membranous basal lobes 2–2.3 mm. long, arising 1 mm. above the sinus; filaments less than 0.5 mm. long; anthers stoutly subulate, 4.8 mm. long; pistil 8.5 mm. long, the conic ovary gradually tapering into the subulate style (Pl. 31, fig. 2; 32).

[1] The Tylerias, on account of their blunt stems, terminal clusters of leaves, and large flowers are perhaps the most arresting group of trees on the summit of Duida, *T. grandiflora* in particular being so widespread as to occur almost everywhere. On the most exposed crests and the deepest, most humid valleys it was scarce, but on the undulating slopes, on the lower part of the Savana Hills, most of the Brocchinia Hills, and even down the promontory to First Ridge it was usually a dominant species. *T. floribunda* and *T. spathulata* were seen about Central Camp, usually in forest about twenty feet high, seeming to affect the more protected slopes and to be absent from exposed places. *T. linearis* has become specialized for growing along the banks of streams. Its branches are supple and resilient and its leaves narrowed. It was seen bordering several of the brooks flowing toward the Caño Negro, which were crossed by the southwest trail.—G. H. H. T.

Hillsides and flat ground at Central Camp, 4800 ft., *540.*

Tyleria grandiflora Gleason, sp. nov. Stipulis parvis late ovatis deciduis; foliis sessilibus rigidis coriaceis anguste elliptico-oblongis apice rotundatis ad marginem scabridulis; floribus axillaribus pedicellatis; sepalis oblongis; petalis oblongo-obovatis magnis; staminodiis cum staminibus alternis erectis membranaceis rigidis spathulatis involutis glandulis magnis 3–6 punctatis; staminodiis ad stamina oppositis brevioribus oblongis acutis non involutis ad dorsum adpresse hirsutis.

Stems woody, the upper branches soon leafless and densely covered with black elliptic leaf-scars, the internodes very short; leaves crowded, sessile, rigid, coriaceous, narrowly elliptic-oblong, 4–5 cm. long, 10–15 mm. wide, rounded at the summit, scabrid on the margin, gradually narrowed from above the middle to the base, the surface glabrous, dull green, opaque and rugulose above, the very numerous veins barely prominent beneath; flowers probably 2–4 on each branch, on slender pedicels 1–2 cm. long; sepals oblong, widest just above the middle, 10 mm. long, 5 mm. wide, acute, glabrous; petals oblong-obovate, 30 mm. long, 13 mm. wide, obtuse, cuneate to the base, pink; staminodes 10, connate for 3 mm. from the base and surrounding the stamens, the five alternate with the stamens erect, firm and stiff, almost transparent, narrowly spatulate, 8.5 mm. long, 1 mm. wide at base, 2 mm. wide near the summit, involute, pinkish in color, rounded at the summit, marked with 3–6 large swollen superficial glands; the five opposite the stamens flat, erect, oblong, 4 mm. long, 1.6 mm. wide, sharply acute, hirsute with stout appressed hairs on the back; anthers sessile, stoutly subulate above a cordate base, acute, 6 mm. long; pistil about 12 mm. long.

Crest of Ridge 25, 6300 ft., *411.*

Tyleria linearis Gleason, sp. nov. Stipulis parvis late triangularibus integris; foliis subcoriaceis non rigidis linearibus acutis margine insigniter ciliatis basi sessilibus cuneatis; floribus solitariis axillaribus breviter pedicellatis; sepalis ovato-lanceolatis acuminatis; petalis obovatis; staminodiis 5 basi cuneatis, segmentis erectis membranaceis petaloideis spathulatis apice rotundatis supra basin ad partem sinistrorsam lobo unico breve subulato munitis; antheris linearibus sessilibus apiculatis.

A bush with slender, nearly black twigs, the internodes about 2 mm. long and the leaf-scars soon evanescent; leaves crowded at the summit of the branches, subcoriaceous, not rigid, linear, 3–5 cm. long, 3–5 mm. broad, acute, conspicuously ciliate with curved-ascending purplish hairs about 1 mm. long and soon deciduous, gradually narrowed to the sessile base, the surface glabrous and opaque; pedicels solitary on each twig, about 1 cm. long; sepals ovate-lanceolate, 10–11 mm. long, 4 mm. wide, sharply acuminate; petals obovate, 20 mm. long, 12 mm. wide, pinkish-white, rounded above from a cuneate base; staminodes 5, alternate with the petals, connate at base for

3.5 mm., the segments erect, membranous, petaloid, spatulate, 7 mm. long, 1 mm. wide at base, 2.5 mm. wide above, rounded at the summit, somewhat involute; each staminode bears on its left side just above the base a flat, triangular-subulate, usually falcate tooth 0.5–1.5 mm. long; anthers sessile, stoutly subulate, 5.4 mm. long, apiculate; ovary narrowly ovoid, 2 mm. long, narrowed into the subulate style 6.5 mm. long (Pl. 33).

Streamside at Central Camp, 4800 ft., *555*.

Tyleria spathulata Gleason, sp. nov. Stipulis parvis late triangularibus integris; foliis ad summum ramorum confertis subcoriaceis non rigidis spathulato-obovatis minute retusis, margine incrassato crenulatis ad basin sessilem longe cuneatis, supra nitentibus, subtus opacis, utrinque glabris, venulis numerosis a vena primaria ad angulam 60° abeuntibus; inflorescentia terminale elongata ramulis brevissimis sparsis 1-floris aut ad basin 2-floris; floribus pedicellatis; sepalis obovatis acutis; petalis obovatis basi non cuneatis; staminodiis 10 basi in tubum brevem connatis; segmentis cum staminibus alternis erectis spathulatis involutis, segmentis ad stamina oppositis ellipticis brevioribus supra medium in lobos lineares 6–8 fissis; antheris sessilibus apiculatis.

A large tree; the broadly triangular stipules soon deciduous and the broadly elliptic leaf-scars soon evanescent, the internodes about 5 mm. long; leaves crowded near the end of the branches, subcoriaceous, spatulate-obovate, 6–11 cm. long, 2–4 cm. wide, the triangular apex minutely retuse, the thickened margin finely crenulate, cuneate from above the middle to the sessile base, upper surface dark green and shining, lower surface dull green with broad midvein; veinlets numerous and parallel, ascending at an angle of about 60°; inflorescence slender, terminal, about 20 cm. long, the short stout branches 2–3 mm. long, swollen at the end and bearing 1, or near the base 2, flowers on stout pedicels 8–10 mm. long; sepals obovate, 10 mm. long, nearly 6 mm. wide when flattened, glabrous, sharply acute, parallel-veined; petals waxy white, obovate, 14 by 8 mm., rounded above, not cuneate below; staminodes 10, connate for 2.3 mm around the stamens; segments alternate with the stamens erect, petaloid, membranous, spatulate, 5.7 mm. long, 0.5 mm. wide above the base, 1.9 mm. wide above, slightly erose at the rounded tip; segments opposite the stamens elliptic, erect, 3–3.3 mm. long, 1.2 mm. wide, split from the summit to the middle into 6–8 narrowly linear segments; anthers sessile, 5 mm. long; pistil 9.5 mm. long, the narrowly conic ovary tapering gradually into the subulate style.

On slopes at Central Camp, 4800 ft., *560*. This species differs strikingly from the three preceding in its general habit, due to the shape of the leaves, the direction of the veinlets, and the character of the inflorescence; it also has leaves thickened at the margin and definitely crenulate, a point purposely omitted from the generic description.

THEACEAE

Lowland species

TERNSTROEMIA CANDOLLEANA Wawra. River banks and flood sands at Muyrapenima, on the Rio Negro, northern Brazil, *61;* known only from the region of the Rio Negro.

TERNSTROEMIA CANDOLLEANA Wawra, var. ANGUSTIFOLIA Wawra. A tree on flooded ground at Camanaos, on the Rio Negro, northern Brazil, *125;* hitherto known only from San Gabriel, on the Rio Negro, where it was originally collected by Spruce.

Species of Mount Duida

ARCHYTAEA MULTIFLORA Benth. Hillsides and flat ground at Central Camp, 4800 ft., *535*, *1034;* a bushy tree with pink flowers 1.5 inches in diameter, hitherto known only from Roraima and adjacent Brazil.

Bonnetia crassa Gleason, sp. nov. Arborescens; ramis crassis apice foliosis inferne cicatricibus foliorum delapsorum dense obtectis internodis brevissimis; foliis coriaceis nitentibus sessilibus oblongo-obovatis apice rotundatis saepe leviter retusis basi rotundatis totidem glabris, venis parallelis sub angulo angusto adscendentibus supra prominulis subtus planis; floribus solitariis pedicellis 15 mm. longis; sepalis oblongis acutis cuspidatis; petalis late triangulari-obovatis apice rotundatis; staminibus liberis, antheris oblongis; ovario 3-loculare; stylo elongato trigono apice breviter lobato.

A large tree, the stout branches leafy only at the summit, elsewhere densely covered with leaf-scars, the internodes exceedingly short; leaves coriaceous, sessile, shining, more or less tinged with red, oblong-obovate, the largest 48 by 28 mm., rounded and often slightly retuse at the apex, rounded at base, ciliate when young, at maturity merely scaberulous on the margin; veins subparallel, ascending at an angle of about 45°, prominulous above, plane beneath; flowers solitary, on peduncles 15 mm. long; sepals oblong, 26 mm. long, 11 mm. wide, broadest above the middle, acute and cuspidate, glabrous; petals broadly triangular-obovate, 45 mm. long, 32 mm. wide, pinkish-white, freely flabellately veined; stamens numerous, separate to the base; filaments filiform; anthers broadly oblong, 1.2 mm. long; ovary narrowly ovoid, 6.5 mm. long, 3-celled, gradually tapering into a stout erect trigonous style 1 cm. long, bearing 3 terminal lobes 1.5 mm. long (Pl. 30, fig. 1).

Hillsides and flat ground at Central Camp, 4800 ft., *539* (type); slopes of Ridge 25, 5500–6000 ft., *413*. The plant is most nearly related to *B. sessilis* Benth., endemic to Roraima, which has obcordate petals, sepals only 12 mm. long and inner ones obcordate, and an entire style bearing a 3-lobed stigma, as well as more slender stems and much longer internodes.

BONNETIA HOLOSTYLA Huber. At Agüita, 3800 ft., *928*, with large red-pink flowers in ample panicles. The specimen agrees precisely with the type, *Ducke 12315*, from the upper tributaries of the Rio Negro in Colombia, and is apparently the second collection of the species.

Bonnetia longifolia Gleason, sp. nov. Arborescens; ramis crassissimis glabris subnitentibus mox defoliatis et verrucosis; foliis ad apicem ramorum confertis, coriaceis, sessilibus, subnitentibus, oblanceolatis saepe inequilateralibus apice retusis margine integris glabrisque a medio ad basin sessilem angustatis, venis lateralibus parallelis sub angulo latiore adscendentibus utrinque vix prominulis; floribus 3–4 terminalibus pedunculo crasso minute puberulo; sepalis late ellipticis coriaceis utrinque rotundatis extus puberulis; petalis obovatis rotundatis; staminibus liberis, antheris elongato-linearibus; ovario 3-loculare; stylo gracile stigmate obscure 3-lobato.

A large tree, the cortex of the stout leafless branches eventually reddish-brown and sparsely marked with very wide and short leaf-scars; leaves crowded at the summit of the branches, coriaceous, somewhat shining, sessile, oblanceolate, often slightly inequilateral, the largest 140 by 42 mm., retuse at the apex, entire and glabrous on the margin, gradually narrowed from above the middle to the base; veins ascending at an angle of about 60°, 1 mm. apart, parallel, slightly elevated above, plane beneath; flowers 3 or 4, terminal, on stout puberulent peduncles 2 cm. long; sepals coriaceous, red-brown, broadly elliptic, 24 mm. long, 14 mm. wide, entire, rounded at both ends, minutely puberulent on the outer side; petals flabellate-obovate, 4 cm. long and wide, pink, rounded above; filaments separate to the base, filiform, 10 mm. long; anthers narrowly linear, 6 mm. long, 0.6 mm. wide; ovary ovoid, 8 mm. long, 3-celled; style straight and slender, 10 mm. long, the stigma obscurely 3-lobed.

Hillsides and flat ground at Central Camp, 4800 ft., *537*, described by the collector as having pink flowers and waxy yellow anthers. *B. longifolia* is related to the two preceding species and to *B. sessilis* Benth. It differs from the latter in its stout branches, very short internodes and triangular petals; from *B. crassa* Gl. in its longer leaves, linear anthers, minutely lobed style, and the direction and character of its leaf-venation; from *B. holostyla* Huber in its thick stems, its closely parallel veins, and its solitary flowers which are much larger in all dimensions.

Bonnetia tristyla Gleason, sp. nov. Arbor magna; ramis satis gracilibus angulatis glabris; foliis brevissime petiolatis subcoriaceis obovato-oblongis ad apicem rotundatum obscure crenatis ad basin obtusam angustatis, venis lateralibus arcuatim adscendentibus utrinque elevatis; floribus solitariis in axillis foliorum superiorum, pedunculo glabro folia duplo excedente; sepalis 3 interioribus late obovatis 2 exteriora multo excedentibus; petalis flabellato-obovatis rotundatis; staminibus liberis antheris brevibus oblongis; stylis 3 omnino distinctis.

A large tree; stems stout, but not swollen as in the preceding species,

angular, glabrous, marked with nearly circular leaf-scars; petioles very stout, about 2 mm. long and wide, very broadly attached to the stem; blades subcoriaceous, obovate-oblong, 7–12 cm. long, 25–50 mm. wide, often somewhat inequilateral, rounded at the summit, somewhat cartilaginous and obscurely crenate, especially toward the apex, the crenations bearing minute spinulose teeth when young, narrowed from above the middle to an obtuse base, glabrous; lateral veins elevated on both sides, arcuately ascending; peduncles solitary in the upper axils, 6–8 cm. long, much exceeding the small upper leaves; outer 2 sepals broadly elliptic, obtuse, coriaceous, about 12 mm. long; inner 3 sepals broadly obovate, rounded at the summit, about 20 mm. long; petals flabellate-obovate, about 35 mm. long and wide; stamens very numerous, the slender filaments nearly 1 cm. long at maturity, separate to the base; anthers oblong, 1.5 mm. long, deeply 2-lobed at the summit; style 3, 9–10 mm. long, separate to the base, considerably dilated and somewhat incurved distally (Pl. 30, fig. 2).

Hillsides and flat ground at Central Camp, 4800 ft., *536*. *Bonnetia tristyla* is at once differentiated from all other known species of the genus by its separate styles. There is no doubt of its generic position within the family Theaceae, its convolute corolla, imbricate calyx, and 3-celled ovary admitting it to no other position unless a new genus is erected for it. Since its habit is entirely that of a *Bonnetia*, it is placed in that genus and the generic description must be extended accordingly. Dr. Melchior, after an inspection of the specimen, concurs in this opinion.

Melchior has presented a key to the species of *Bonnetia* in Natürlichen Pflanzenfamilien ed. 2, **21:** 150, which may now be expanded by the incorporation of the three additional species described above.

- Filaments free.
  - Styles 3, separate to the base — *B. tristyla* Gleason.
  - Style 1, 3-branched near the apex.
    - Flowers in loose leafless panicles — *B. paniculata* Spruce.
    - Flowers axillary.
      - Peduncles elongate, mostly 3-flowered — *B. anceps* Mart.
      - Peduncles shorter than the leaves — *B. Dinizii* Huber.
  - Style undivided; stigma 3-lobed.
    - Flowers numerous in a loose open panicle — *B. holostyla* Huber.
    - Flowers solitary in the axils.
      - Anthers elongate-linear — *B. longifolia* Gleason.
      - Anthers oblong.
        - Petals obcordate; sepals 12 mm. long — *B. sessilis* Benth.
        - Petals obovate; sepals about 25 mm. long — *B. crassa* Gleason.
- Filaments connate at base.
  - Leaves coriaceous.
    - Filaments irregularly united at base — *B. venulosa* Mart.
    - Filaments united in 5 bundles — *B. roraimae* Oliver.
  - Leaves membranous — *B. stricta* Nees & Mart.

LAPLACEA SEMISERRATA (Mart. & Zucc.) Camb. Agüita, 3100 ft., *934*, a small tree; dry laterite soil, Savanna Hills, 4400 ft., *787;* an exceedingly polymorphic species of wide distribution in tropical America, ranging from Mexico south to Bolivia and southern Brazil.

The genus *Ternstroemia* L. f. is considered to include about thirty species in South America. The collections from Duida contain no less than seven well-marked species, none of which can be referred to any previously described forms. They are distinguished among themselves as follows:

Styles 3, separate to the base; sepals long-acuminate — *T. tristyla.*
Style 1, with an expanded discoid stigma; sepals semicircular — *T. discoidea.*
Style 1, with a minute punctiform stigma.
  Capsule 1-celled, 1-seeded; sepals semicircular — *T. monosperma.*
  Capsule 2-celled, several-seeded.
    Sepals sharply acuminate — *T. pungens.*
    Sepals rounded or minutely apiculate, glandless; leaves 5–7 mm. wide — *T. duidae.*
    Sepals minutely apiculate, at least the outer glandular-serrate; leaves 12–18 mm. wide.
      Leaves elliptic, obtuse at base, strongly revolute — *T. dura.*
      Leaves narrowly cuneate, flat — *T. paucifolia.*

Ternstroemia tristyla Gleason, sp. nov. Ramis teretibus glabratis; foliis parvis sessilibus coriaceis anguste cuneato-obovatis apice minute retusis minutissime calloso-denticulatis aveniis, subtus brunneis rugosis; pedicellis brevibus complanatis; bracteolis angustis oblongo-linearibus; sepalis induratis involutis anguste ovatis longe acuminatis margine membranaceis eglandulosis; ovario 3-loculare stylis 3 persistentibus.

Branches terete and glabrous, leafy toward the summit; leaves sessile, coriaceous, narrowly cuneate-obovate, the largest 30 by 13 mm., rounded to a minutely retuse apex, with minute callous teeth depressed below the margin, veinless except for the inconspicuous midnerve, green and plane above, brownish green and rugulose beneath; pedicels from the upper axils, stout, flattened, 2 cm. long; bracteoles oblong-linear, 5 mm. long, obtuse, carinately nerved; fruiting sepals 13 mm. long, stiff, involute, narrowly ovate, long-acuminate, the margin membranous and not glandular; petals narrowly triangular, 6.5 mm. long; capsule round-ovoid, 3-celled, few-seeded, ending in the three persistent styles.

Brocchinia Hills, 4500 ft., *584*. This is apparently the only American species with three distinct styles.

Ternstroemia discoidea Gleason, sp. nov. Ramis junioribus angulatis et striatis; petiolis brevibus rugosis; foliis elliptico-oblongis vel cuneato-oblongis, coriaceis, minute retusis, integris, ad basin cuneatis, nervo medio supra impresso subtus prominente, venulis nullis, supra opacis glabris subtus cinnamomeis rugosis; pedicellis multis confertis nutantibus rugosis; bracteis

parvis ovatis; sepalis 2 extimis rotundo-ovatis glanduloso-serratis, 3 intimis late oblongis eglandulosis, omnibus rotundatis; petalis late obovatis; filamentis elongatis, antheras aequantibus aut excedentibus; antheris oblongis apiculatis; ovario 1-loculare; stigmate discoideo.

A bush 8 feet high with white flowers; younger branches slender, conspicuously angled and striate; petioles stout, 5–8 mm. long, rugose; leaf-blades coriaceous, ascending, narrowly obovate, the largest 46 by 19 mm., minutely retuse, entire and somewhat revolute, cuneate to the base, veinless except for the midnerve, the upper surface opaque, dull green, glabrous, with strongly impressed midnerve, the lower surface cinnamon brown, rugose, with elevated midnerve; pedicels crowded at the base of the shoots of the season, angular and rugose, nodding, 20–25 mm. long, usually with a minute bracteole 5–8 mm. from the summit; bracteoles appressed to the calyx, triangular-ovate, about 2 mm. long, serrate, at least near the apex; outer two sepals broadly round-ovate, firm and coriaceous, 4 mm. long and nearly as wide, rounded at the summit, glandular-serrate; inner three sepals broadly oblong, 3.7 mm. long, 4.8 mm. wide, truncate, thinner and membranous toward the entire margin; petals broadly obovate, 5.5 mm. long and wide, strongly curved inward on the sides; stamens numerous; filaments filiform, 1.5–2.7 mm. long; anthers narrowly oblong, 1.5–2 mm. long, abruptly narrowed to a subulate appendage 0.3–0.5 mm. long; ovary broadly conic, 1-celled, about 2 mm. long, gradually tapering into a straight style of the same length; stigma discoid, 0.7 mm. in diameter.

Slopes of Ridge 25, 5500–6000 ft., *405*. It is apparently related to *T. alnifolia* Wawra, a species of quite different habit from central and southern Brazil.

Ternstroemia monosperma Gleason, sp. nov. Ramis cinereis vel albidis juventute rugosis; petiolis crassis brevibusque; foliorum laminis cuneato-obovatis vel cuneato-oblongis, apice minute retusis, margine integris et remote punctatis, basi cuneatis, supra opace viridibus glabris, subtus brunneis rugulosis nigro-punctatis; pedicellis paucis divaricatis; sepalis late rotundatis valde rugosis integris; capsula ovoidea suberosa; semine solitario ovoideo.

A freely branched shrub, the branches pseudo-verticillate, rugose when young, gray or nearly white during the second season, later dull gray with numerous longitudinal clefts in the bark; petioles appressed, rugulose, about 5 mm. long; leaf-blades coriaceous, cuneate-obovate or cuneate-oblong, the largest 45 by 20 mm., minutely retuse, entire, somewhat revolute, and sparsely glandular-punctate at the margin, cuneate to the base, veinless except for the midnerve, upper surface pale dull green with strongly impressed midvein, lower surface bronze-green, minutely rugulose, black-punctate; pedicels few, spreading, rugose, 20–25 mm. long; bracteoles appressed to the calyx, broadly ovate, 2–3 mm. long; fruiting sepals almost semicircular, 9–10 mm. wide by half as long, rugose, the membranous margin entire; capsule rugose, ovoid, 13 mm. long, 1-celled; seed ovoid, 7 mm. long; style deciduous.

Central Camp, 4800 ft., *1019*.

Ternstroemia pungens Gleason, sp. nov. Ramis teretibus lenticellis elongatis dense obtectis; petiolis brevibus; foliis obovatis subcoriaceis, apice truncatis vel rotundatis, obscure retusis, margine integris remote punctatis, base acutis vel late cuneatis, supra glabris nitentibus obscure venosis, subtus brunneis glabris nigro-punctatis; pedicellis gracilibus apice nutantibus; sepalis fructiferis induratis ovatis longe acuminatis integris; capsula subglobosa 2-loculare; seminibus nigris parvis; stylo deciduo.

Young branches freely marked with lenticels which on the older wood become much widened; petioles stout, rugulose, 3–4 mm. long; leaf-blades subcoriaceous, obovate or obovate-oblong, the largest 55 by 32 mm., rounded or truncate above and minutely retuse, entire, slightly revolute, and remotely black-punctate on the margin, acute or broadly cuneate at base; upper surface bright green, shining, glabrous, with impressed midvein and obscure lateral veins; lower surface bronze-green, minutely rugulose, glabrous, freely black-punctate; pedicels few, slender, 3 cm. long, nodding at the summit, somewhat flattened, glabrous; bracteoles deciduous; fruiting sepals brown, indurated, ovate-lanceolate, long-acuminate, entire (or rarely remotely glandular), 12 mm. long; capsule subglobose, 1 cm. in diameter, slightly rugulose, 2-celled; style soon deciduous; seeds small and black.

A bush on dry slopes of the Savanna Hills, 4400 ft., *837* (type); a large bush between Ridge 23B and 23C, 6100 ft., *696*.

Ternstroemia duidae Gleason, sp. nov. Ramis gracilibus longitudinaliter striatis mox fissis; petiolis brevibus rugosis; foliis lineari-oblanceolatis, subcoriaceis obtusis integris supra opace viridibus glabris subtus brunnescentibus aveniis; pedicellis paucis gracilibus nutantibus glabris; sepalis late ovatis superne rotundatis apiculatisque margine membranaceis convolutis; petalis lanceolato-oblongis erectis apice rotundatis margine supra medium scarioso inflexo; filamentis brevibus; antheris lineari-oblongis apiculatis; ovario conico 2-loculare stylo subulato indiviso multo superato.

Shrubby, the branches pseudo-verticillate, slender, finely longitudinally striate when young, after the first season marked by numerous longitudinal fissures; petioles slender, 3–5 mm. long, rugulose; leaf-blades linear-oblanceolate, subcoriaceous, the largest 45 by 6 mm., obtuse, entire, flat, long-cuneate to the base, the midvein impressed above, plane beneath, veinlets none; upper surface dull green and glabrous; lower surface brownish green and rugulose; pedicels few, slender, nodding, 2.5–3 cm. long, striate; bracteoles ovate-lanceolate, 4–7 mm. long; sepals broadly ovate, coriaceous and brown when dry, pinkish when fresh, 10 mm. long by 6 mm. wide, rounded to an apiculate tip, the margins subscarious and crisped, not glandular; petals lance-oblong, erect and connivent, 10.5 mm. long, 3.2 mm. wide, obtuse, firm in texture below, above the middle with scarious involute margins; stamens 25; filaments stout, 1.5 mm. long; anthers linear-oblong from an oblique base, 3.5 mm. long, acu-

minate into a subulate beak 1.5 mm. long; ovary short-conic, 2-celled with several ovules; style subulate, undivided, 5–6 mm. long.

A shrub 6 feet high with pinkish -white petals, slopes of Ridge 25, 5500–6000 ft., *459*.

Ternstroemia dura Gleason, sp. nov. Ramis juvenilibus rotunde angulatis sulcatis mox teretibus; petiolis crassis erectis brevissimis; foliis crasse coriaceis ellipticis retusis basi obtusis margine integris ad medium revolutis, supra viridibus subnitentibus subtus brunneis rugulosis; pedicellis crassis rugosis nutantibus; sepalis coriaceis ovatis apice apiculatis vel obtusis extimis glanduloso-serratis intimis integris vel remote glandulosis; capsula ovoidea 2-loculare stylo elongato persistente.

A shrub with few subverticillate branches, the younger ones roundly angled and sulcate, the older terete with numerous longitudinal fissures; petioles broad, rugose, 1–2 mm. long; leaf-blades thick and coriaceous, elliptic-oblong, the largest 30 by 12 mm., broadest near the middle, obtuse and slightly retuse, entire, revolute to the midvein, obtuse at base; upper surface green and somewhat shining, the midvein barely impressed, the veinlets none; lower surface brown and rugulose, the obscure midvein plane; pedicels few, stout, 3 cm. long, rugose; bractlets oblong-obovate, 3–4 mm. long; sepals ovate or ovate-oblong, 11 mm. long in fruit, obtuse or minutely apiculate, the outer glandular-denticulate, the inner entire and membranous at the margin or remotely glandular; capsule ovoid, 16 mm. long, slightly rugulose, 2-celled, the persistent style 9 mm. long.

Brocchinia Hills, 4500 ft., *1017* (type); summit of Peak 7, 7100 ft., *656*.

Ternstroemia paucifolia Gleason, sp. nov. Ramulis angulatis mox teretibus; petiolis brevibus crassis rugulosis; laminis cuneato-oblongis coriaceis minute retusis integris basi cuneatis supra glabris opacis vena vix impressa, subtus nigrescentibus rugulosis; pedicellis paucis complanatis divaricatis, sepalis fructiferis late ovatis vel obovatis integris; capsula biloculare subglobosa stylum persistentem excedente.

A shrub with scattered leaves, the branches pseudo-verticillate, somewhat angled when young, terete in age; petioles stout, rugose, about 5 mm. long; leaf-blades coriaceous, flat, narrowly cuneate-oblong, the largest 45 by 13 mm., rounded to a minutely retuse tip, entire, long-cuneate at base, glabrous with impressed midvein above, minutely rugulose beneath, the veinlets obsolete; pedicels stout, flattened, spreading, 3 cm. long, longitudinally striate; bracteoles narrowly oblong, 5 mm. long; sepals at maturity broadly ovate or obovate, about 9 mm. long, obtuse and apiculate; capsule globose, 13 mm. in diameter, rugulose, 2-celled, the persistent style 5 mm. long.

Crest of the Savanna Hills, 4400 ft., *859*.

Number *613*, from the summit of Peak 7, 7100 feet, a sterile plant of this genus, probably *T. pungens* Gleason.

GUTTIFERAE

Lowland species

CLUSIA COLUMNARIS Engl. A small tree at Buena Vista, on the Rio Casiquiare, *159;* rocky top of Esmeralda Ridge, *193;* on the Tree Savannas at Esmeralda, *317*. The species has been known apparently only from its original collection by Spruce at San Carlos, on the upper Rio Negro. The type has longer and proportionately narrower leaves: our specimens agree in all other respects.

MAHUREA EXSTIPULATA Benth. Middle Camp at Esmeralda, *945*, a tree with pink flowers. The species is common through the savanna region of northern South America.

VISMIA JAPURENSIS Reichardt. Yucabí, on the Rio Negro, northern Brazil, *966;* known only from a few stations in the region of the upper Amazon and Rio Negro, but possibly with considerably wider distribution.

Species of Mount Duida

Clusia duidae Gleason, sp. nov. Caulibus satis gracilibus, internodis brevibus; foliis sessilibus subcoriaceis flavo-virescentibus oblongo-oblanceolatis subacutis basi longe angustatis ad basin obtusam, venis lateralibus directis utrinque elevatis ad angulam 45° adscendentibus; panicula ramosa pauciflora pedicellis flores subaequantibus; bracteis coriaceis cordatis subamplexicaulibus subacutis; sepalis 6 orbicularibus coriaceis interioribus gradatim longioribus; staminodiis 4, filamentis latis complanatis ad basin contiguis; stylis 4 crassis brevibus angulatis divergentibus; stigmatibus orbicularibus; seminibus in quoque loculo circ. 10 ellipsoideis.

Stems rather slender and straight, the internodes 10–15 mm. long; leaves sessile, the blades subcoriaceous, yellowish green, oblong-oblanceolate, 6–8 cm. long, 21–30 mm. wide, narrowed or subacuminate above to a subacute tip, narrowed from above the middle to an obtuse base; lateral veins numerous, straight and parallel, 1–2 mm. apart, elevated on both sides, ascending at an angle of 45°, connected near the margin by a prominent collective vein; panicles terminal, branched, few-flowered, the branches subtended by triangular-ovate bracts 2–4 mm. long; pedicels 6–12 mm. long, strongly bisulcate; bracts below each flower cordate, 2.4 mm. long, 2.7 mm. wide, leathery, subacute, somewhat clasping at base; sepals 6, coriaceous in the middle, scarious at margin, orbicular, 4, 5, or 6 mm. long, 4.5, 5.2, or 5.7 mm. wide; within the sepals and concealed by them 2 orbicular organs 3 mm. long and 3.5 mm. wide; staminodes (or stamens?) 4, 2.2 mm. long, very flat, 1.3 mm. wide at the contiguous bases, bearing distally 2 lateral pollen-sacs (sterile?) opening by longitudinal clefts; styles very stout and angular, somewhat divergent, 1 mm. long; stigmas 4, orbicular, 1.6 mm. in diameter; capsule prismatic, 15 mm. long, 4-celled; seeds about 10 in each loculus, narrowly ellipsoid, 2.7 mm. long, more or less surrounded, especially at base, by a gelatinous substance.

Slopes of Ridge 25, 5500–6000 ft., *429* (type); at Valley Head, 5000 ft., *1033*. Without staminate flowers it has been impossible to refer this species satisfactorily to a section of the genus. Nothing to match it has been found in the large European collections examined.

Clusia hexacarpa Gleason, sp. nov. Arbor magna ramis crassis in siccitate angulatis; petiolis crassis subalatis; foliis coriaceis ellipticis superne rotundatis basi obtusis vel subacutis utrinque purpureo-lineatis; venis lateralibus directis parallelis vix elevatis sub marginem vena collectiva inconspicua connexis; floribus femineis solitariis breviter pedunculatis; bracteis 2 coriaceis late orbicularibus; sepalis 4 subaequalibus rotundo-obovatis; petalis 6, coriaceis obovatis; staminodiis 9 crassis erectis oblongis superne triangularibus thecis sterilibus marginalibus; stylis 6 carnosis ad ovarii summum adpressis; stigmatibus 6 excentrice peltatis.

A large spreading tree, the stout branches strongly angled when dry and scabrellate; petioles very stout, 6–15 mm. long, flattened above, sharply margined or almost winged; blades coriaceous, elliptic, 4–7 cm. long, 2.5–4 cm. wide, broadly rounded at summit, obtuse or subacute at base, minutely marked with purple lines on both sides; lateral veins straight and parallel, scarcely elevated, united by an inconspicuous marginal collective nerve; peduncles stout, 2 cm. long; pedicels stout, solitary, 5 mm. long, subtended by 2 rotund bracts 1 cm. long; bracts below each flower 2, broadly orbicular or depressed, semi-amplexicaul, 4 mm. long, 5.5–6 mm. wide, carinate down the middle; sepals 4, broadly rotund-obovate, 10 mm. long, 8.5 mm. wide, leathery in the center, membranous at the margin; petals 6, leathery, white, obovate, 12–14 mm. long, 7–8 mm. wide, often slightly falcate, broadly rounded above; staminodes 9, fleshy, erect, oblong, 3 mm. long, 1.5 mm. wide, the summit triangular, acute, with imperfect marginal anthers; carpels 6; styles 6, fleshy, radiating from summit of ovary and appressed to it, slightly recurved, 1.6 mm. long; stigmas yellow, fleshy, excentrically peltate, 3–3.5 mm. in diameter.

Streamside at Central Camp, 4800 ft., *565*. It is a member of the section *Eucriuva* Engl., and shows a general similarity to *C. cajamarcensis* Engl., but the latter has thicker opaque sessile leaves, with the lateral veins quite evanescent above. The two are alike in the number of bracts, sepals, and petals. *Clusia sphaerocarpa* Tr. & Pl. more nearly resembles our species in foliage, but its leaves are narrower, thinner, and with the lateral veins more ascending, the flowers are much smaller, the petioles are shorter, and the stems less strongly angled.

Clusia Melchiori Gleason, sp. nov. Caulibus crassis internodis brevibus; foliis breviter petiolatis crasse coriaceis revolutis, obovato-oblongis rotundatis ad basin longe cuneatis, venis lateralibus rectis sub angulo 45° adscendentibus supra elevatis subtus planis; inflorescentia multiflora paniculata

axibus insigniter compressis ad nodos bracteis triangularibus suffulta; bracteis 4 triangulari-ovatis acutis carinatis; sepalis 4 obtusis margine membranaceis externis 2 subrotundis internis late ovatis; carpellis 4; stylis crassis erectis conniventibus, stigmatibus oblique truncatis; seminibus in loculo uno 2 in ceteris quoque 1.

Stems stout, subterete, the internodes 10–15 mm. long; petioles very stout, 10 mm. long, flattened on the upper side; blades very thick and heavy, oblong-obovate, rounded above, cuneate from above the middle to the base, cinereous above when dry, the lateral veins 2–3 mm. apart, straight and parallel, ascending at an angle of 45°, prominently elevated above, plane beneath; panicles many-flowered, about 10 cm. long, its stout axes conspicuously flattened, subtended at the nodes by ovate-triangular bracts 5 mm. long; flowers crowded on short strongly angled pedicels; bracts 4, triangular-ovate, very thick, acute, carinate, the outer 2.5 mm. long and wide, the inner 3.5 mm. long, 4 mm. wide; sepals 4, obtuse, coriaceous in the center, thin at the margin, the outer triangular-subrotund, 3.7 mm. long, 4.3 mm. wide, the inner broadly ovate, 4 mm. long, 3.5 mm. wide; young fruit ovoid; carpels 4; styles 4, fleshy, erect, connivent, 2.4 mm. long; stigmas obliquely truncate, 0.8 mm. in diameter; seeds 2 in one cell and 1 in each of the other 3.

Desfiladero, 6000 ft., *705*. Dissections by Melchior at Berlin revealed the peculiar number of the ovules and showed that the seed-covering (Samenmantel) is membranous. These characters distinctly suggest the genus *Havetia*, especially the seed-covering, which Melchior regards as of more importance than the number of ovules. He considers, however, that it is better regarded as an aberrant member of the genus *Clusia*, in which it closely resembles *C. flaviflora* Engl. in the shape and venation of its leaves, the enlarged petiole-base, and the flattened branches of the inflorescence. *C. flaviflora* has thinner, green, proportionately broader, more abruptly cuneate leaves; the cyme has a longer peduncle, and the flowers are probably larger. Especially, it has 4 ovules in each of the 4 loculi, as determined by Melchior, although the original description calls them "biovulatis."

(*Continued in the October Issue*)

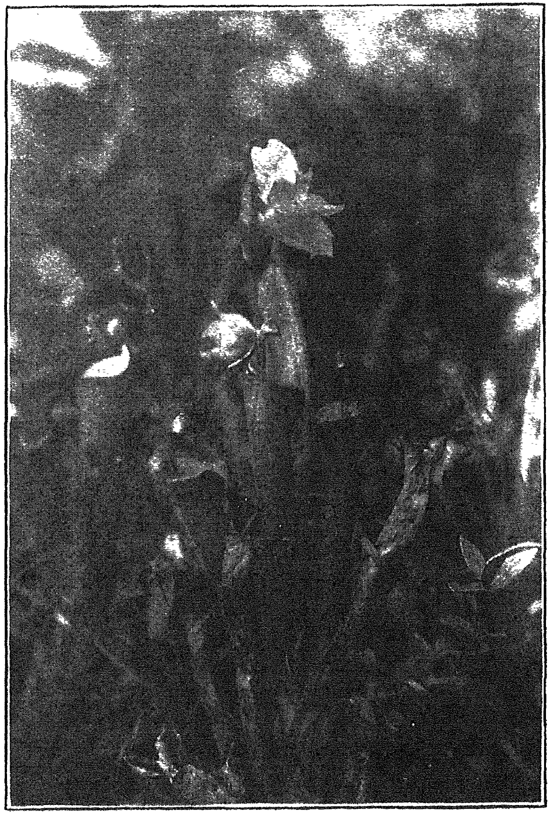


FIG. 1. HELIAMPHORA MACDONALDAE

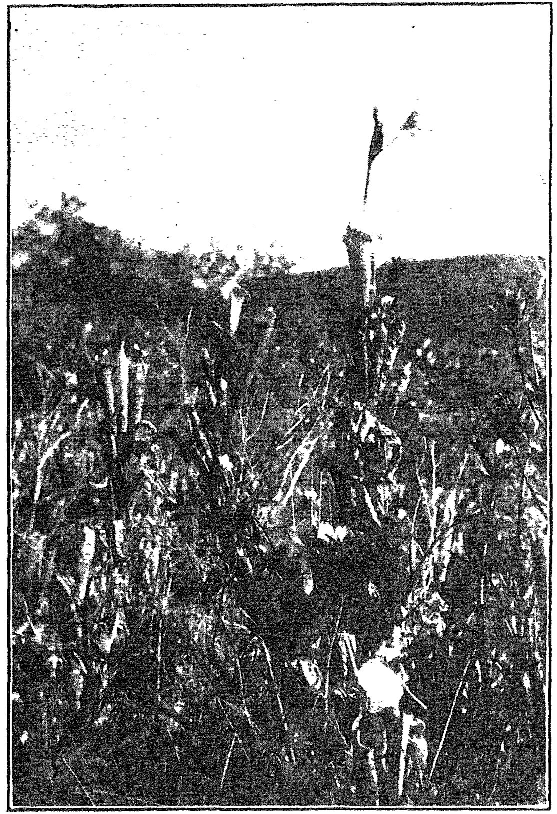


FIG 2. HELIAMPHORA TYLERI

FIG 1 PHORADENDRON DUIDANUM

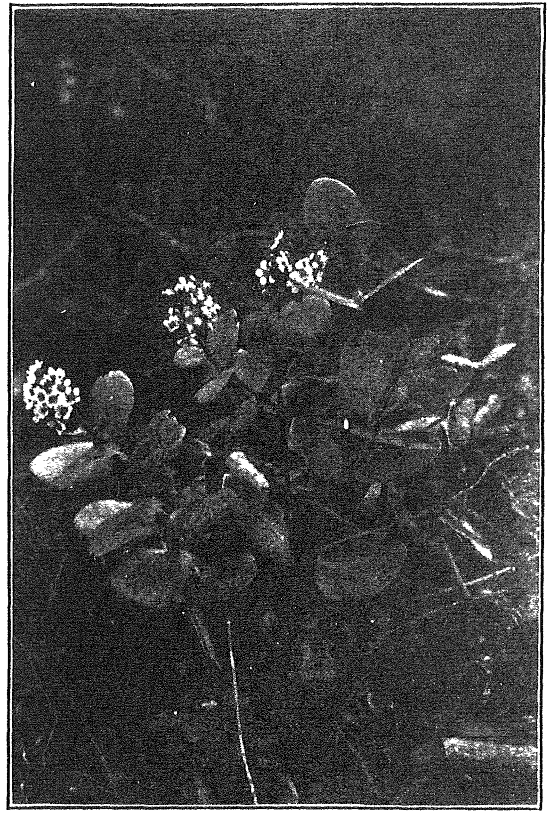
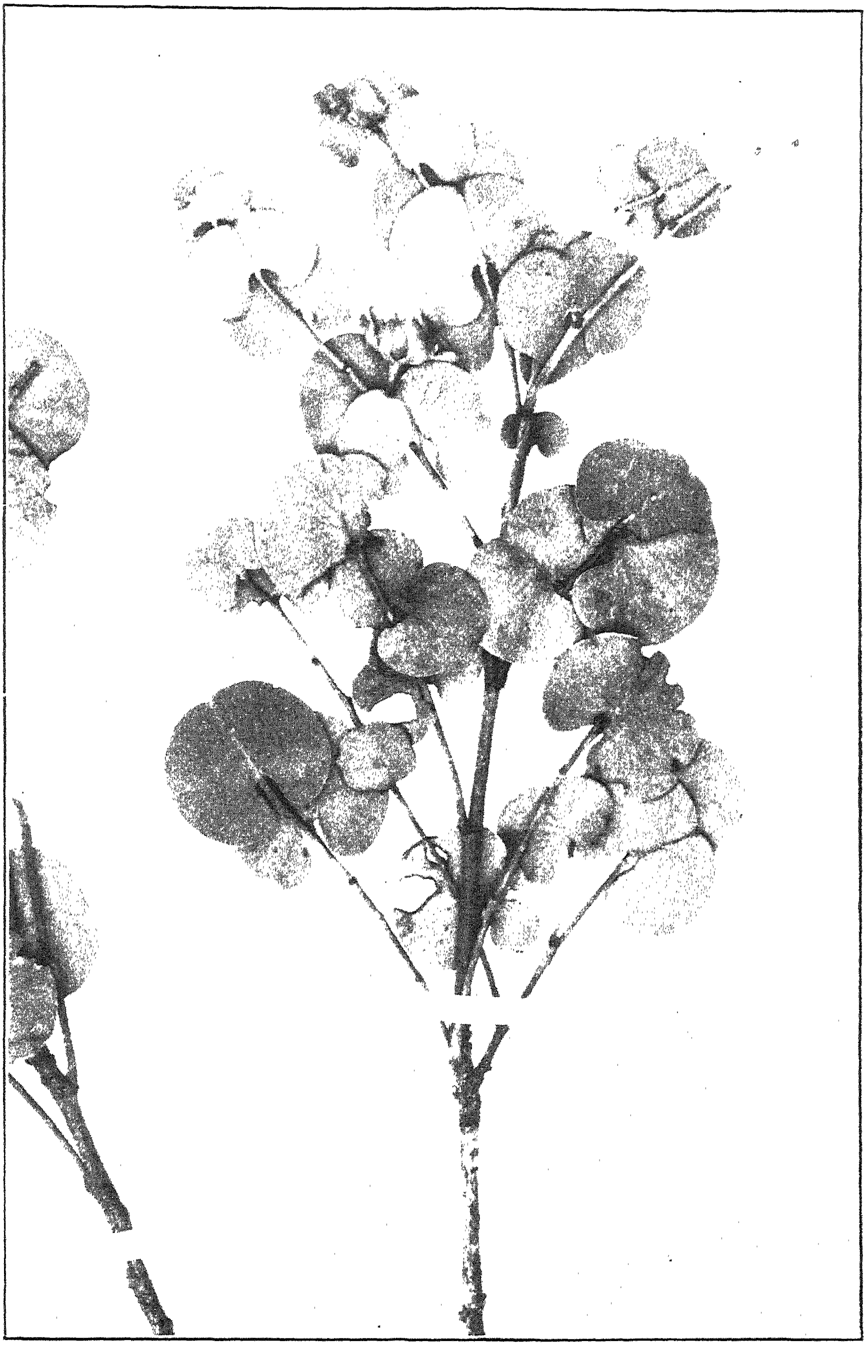


FIG. 2. BYRSONIMA CRETACEA



PHYLLANTHUS DUIDAE

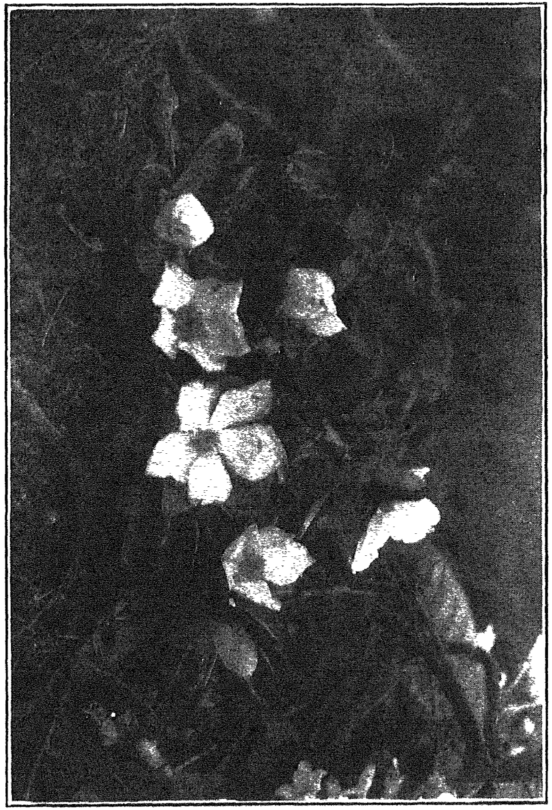


FIG. 1. BONNETIA CRASSA

FIG. 2 BONNETIA TRISTYLA

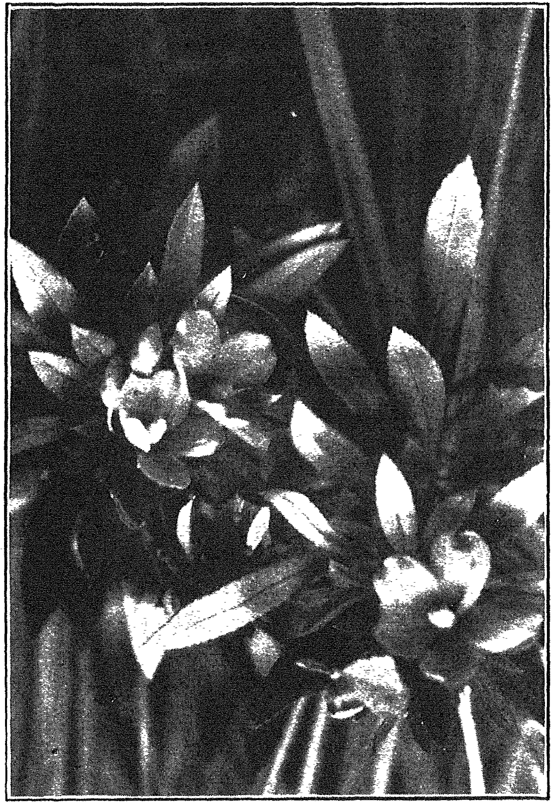


FIG 1. LUXEMBURGIA DUIDAE

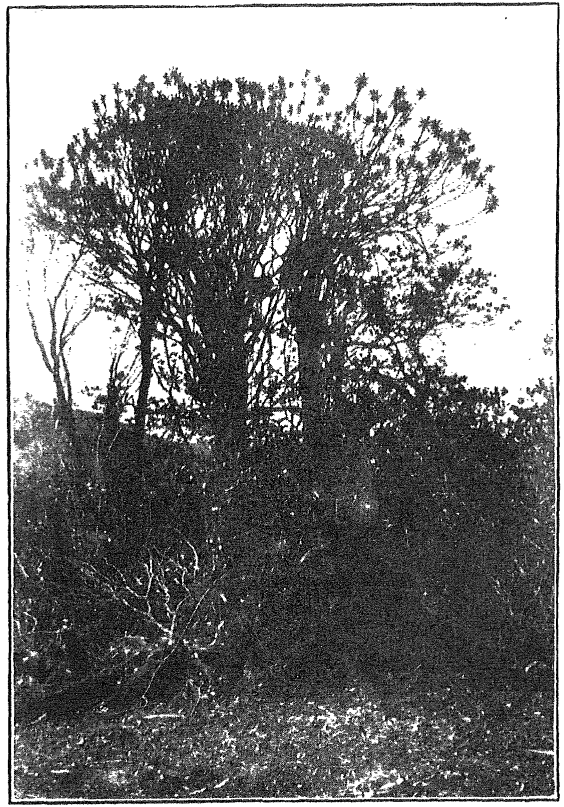
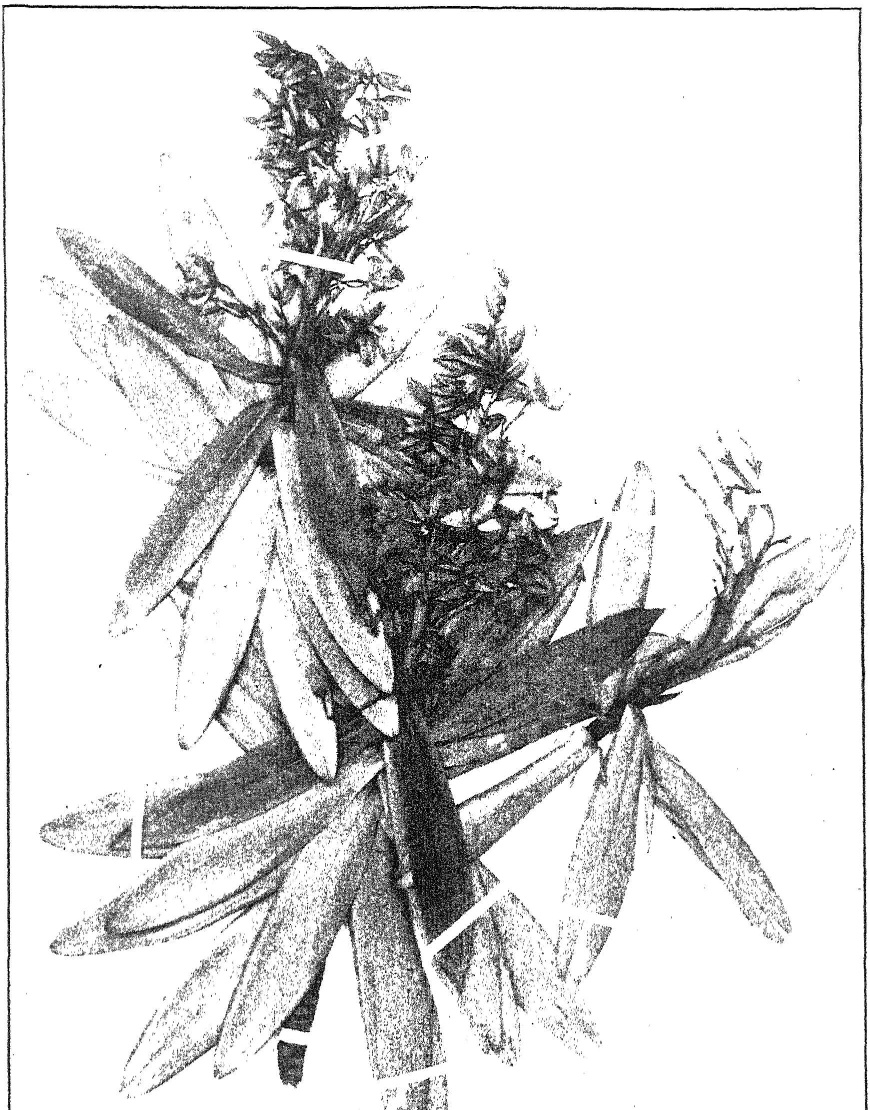


FIG 2. TYLERIA FLORIBUNDA



TYLERIA FLORIBUNDA × 2/5

FIG 1, TYLERIA LINEARIS

FIG. 2. TYLERIA LINEARIS

Botanical results of the Tyler-Duida Expedition

H. A. GLEASON

(*Continued from the June issue*)

GUTTIFERAE

Clusia pachyphylla Gleason, sp. nov. Ramis crassis obscure quadrangulatis in sicco sulcatis; petiolis robustis margine anguste angulatis; laminis rigidis flavescentibus ellipticis utrinque rotundatis vel late obtusis revolutis, costis utrinque prominulis; floribus terminalibus solitariis, pedunculis crassis sulcatis; bracteis 4 coriaceis late ovatis; sepalis 7 coriaceis rotundatis, extimis late ovatis intimis obovatis multo majoribus; petalis 7 obovatis; staminodiis in floribus femineis 28 obscure biseriatis, filamentis erectis crassis; carpellis 7, stylis brevibus, stigmatibus carnosis extrorsis dilatatis.

Arborescent, the branches very stout, 10 mm. in diameter, obscurely 4-angled and strongly sulcate, at least when dried, the internodes 15–20 mm. long; petioles somewhat amplexicaul, stout, 15–20 mm. long, rounded on the back, flattened above, narrowly 2-winged; blades yellowish, very thick, rigid, elliptic, 6–10 cm. wide, 8–18 cm. long, rounded or broadly obtuse at both ends, strongly revolute, lateral veins about 5 mm. apart, ascending at an angle of 70–90°, prominulous on both sides, the secondary veins scarcely obvious but reticulate; latex tubes obscure, 1–2 mm. apart, ascending at an angle of 60°; uppermost or bracteal leaves greatly reduced; flowers terminal, solitary, on thick sulcate peduncles 15 mm. long; bracts, sepals, and petals thick and leathery, the former two crimson, the petals pink or white; bracts 4, broadly round-ovate, 8 mm. long, 10–12 mm. wide; outer sepals almost semicircular, 12 mm. long, 18 mm. wide, the inner elongating to broadly obovate, 23 mm. long by 20 mm. wide; petals 7, obovate above a narrowed base, 36 mm. long, 24 mm. wide; staminodia apparently 28, obscurely biseriate and irregularly united into phalanges of 3 or 4, their filaments stout, barely flattened, strictly erect, 5 mm. long, terminating in an imperfect 2-celled anther; carpels 7, united into a thick fleshy column to the summit of the staminodia, thence abruptly contracted into short styles; stigmas fleshy, elliptic, extrorse, 5 mm. long, 4 mm. wide; staminate flowers not seen.

Summit of Peak 7, 7100 feet, *609* (type); a large, coarse, woody plant at Provisional Camp, 5700 feet, *572*. The structure of the pistillate flowers leaves no doubt of its position in Section 1, *Clusiastrum* Pl. & Tr., at least three other species of which are known from the Roraima region. Our species differs from all of these in the rounded base of the leaf.

[THE BULLETIN FOR JUNE (58: 345–404) WAS ISSUED 11 DECEMBER 1931.]

CLUSIA PLANCHONIANA Engl. Dry laterite soil, Savanna Hills, 4400 ft., *790;* fruit yellow, pear-shaped, 2 inches long. It is a native of the upper Rio Negro valley, originally collected at San Gabriel.

Clusia rotundifolia Gleason, sp. nov. Ramis inter nodos valde compressis, ad nodos fragilibus; foliis perrigidis, sessilibus, rotundatis vel late obovatis, apice rotundatis vel obscure retusis, basi rotundatis vel subcordatis, revolutis, venis supra obscuris subtus prominulis; corymbis 1 vel 2 terminalibus pedunculatis 3-floris bracteis obovatis sessilibus suffultis; pedicellis brevibus crassis, bracteis 6 terminalibus triangularibus vel rotundatis; sepalis 4 extimis rotundatis intimis late obovatis; petalis 4, triangulari-obovatis basi cuneatis; staminibus 16 liberis, filamentis crassis erectis antheras lineari-oblongas aequantibus.

Stems woody, stout, easily broken at the nodes, the internodes 2–4 cm. long, strongly compressed, obscurely sulcate; leaves sessile, extremely thick and rigid, rotund or broadly obovate, 6–8 cm. long and wide, rounded or slightly retuse above, revolute, broadly rounded or subcordate at base, lateral veins about 3 mm. apart, ascending at an angle of 45–60°, almost obsolete beneath, somewhat prominulous above; latex-tubes obscure, ascending at an angle of 30°; inflorescences 1 or 2, terminal, 3-flowered, on stout, strongly sulcate peduncles 25–45 mm. long, bearing at the summit 2 obovate sessile bracts 12 mm. long; pedicels stout, 6–8 mm. long; bracts 6, the outer 2 sessile, triangular, subacute, strongly carinate, fleshy, 4 mm. wide, 1.5 mm. long, the second pair rotund, 3 mm. long and wide, the third pair rotund-reniform, 3 mm. long, 4 mm. wide; sepals 4, thick and fleshy in the middle, with a thin margin 1 mm. wide, the outer pair orbicular, 7 mm. long, the inner broadly elliptic or obovate, 7.5 mm. long, 6 mm. wide; petals 4, obovate-triangular, 10 mm. long, 6 mm. wide, subtruncate or slightly retuse above, cuneate from above the middle to the narrow base; stamens in the staminate flower 16, free; filaments stout, erect, 1.7 mm. long; anthers strictly terminal, narrowly oblong, 1.6 mm. long; pistillate flowers not seen; fruit globose-ovoid, 2 cm. in diameter (Tate), 4-celled with numerous seeds.

Dry ridge-top and moist slopes, Savanna Hills, 4400 feet, *798*. Although pistillate flowers are not available, the species seems to belong without doubt to the Andean section *Anandrogyne* Pl. & Tr., and is distinguished from the other species of the section by its 4-merous flowers and round sessile leaves.

CLUSIA sp. A sterile specimen from a dry ridge in the Savanna Hills, 4400 ft., *797*, greatly resembles *C. pachyphylla* Gleason in the character of its leaves, but has petioles as much as 4 cm. long and proportionately more slender.

Oedematopus duidae Gleason, sp. nov. Arbuscula ramosa; foliis parvis subsessilibus coriaceis obovatis ad basin cuneatis; inflorescentia breviter

pedunculata terminale 1–3 flora; pedicellis brevibus bibracteatis; sepalis 4 suborbicularibus petala orbicularia excedentibus; staminodiis floris feminei 8 basi dilatatis superne filiformibus, antheris cuneatis; ovario 4-loculare multiovulato; stylis 4 brevissimis; stigmatibus peltatis pentagonis.

A low straggling tree with milky juice (Tate); branches dark gray, obscurely 4-angled and sulcate; leaf-blades dull green, thick and coriaceous, obovate, the largest 50 mm. long by 20 mm. broad, rounded above, somewhat revolute, cuneate from above the middle to an angular petiole 2–3 mm. long, lateral veins obscure, ascending at an angle of about 45°, the veinlets obsolete; laticiferous tubes ascending at an angle of about 30°; inflorescence of 1–3-flowered terminal clusters, on strongly 4-angled peduncles 5 mm. long; pedicels 3 mm. long, subtended by a pair of broadly ovate, subacute, sessile bracts 3 mm. long; bracts round-ovate, carinate, subacute, 2.5 mm. long, 3 mm. wide; sepals rotund, the outer pair 3 mm. long, 4 mm. wide, the inner pair 5 mm. long and 6 mm. wide; petals not seen; stamens in the pistillate flower 8, the filaments dilated at base into depressed-ovate portions 1 mm. wide and 0.8 mm. long and more or less connate, the filament proper slender but flattened, 1.8 mm. long; anthers obovate, retuse, cuneate at base, 0.6 mm. long, 0.5 mm. wide, opening by lateral clefts; ovary 4-celled with many ovules; styles very short (about 0.2 mm.); stigmas peltate, pentagonal, 1 mm. in diameter; fruit subglobose, 1 cm. long.

Bank of stream at Central Camp, 4800 feet, *559* (type); Savanna Hills, 4400 feet, *1037;* near summit of Ridge 25, 6000 feet, *523.* Although the petals were not found, they could not have been very large, since the collector notes that the diameter of the flowers is only 6–8 mm. The species stands next to *O. obovatus* Pl. & Tr., of the lowlands in the Duida region, which has larger leaves, much larger inflorescences, smaller bracts, and filaments thickened at base as well as dilated. The three specimens of the Duida collection are remarkably alike in foliage. The one from lowest altitude is in fruit, the type in bloom, and the one from the highest level is still in bud.

BIXACEAE

Lowland species

BIXA ORELLANA L. In second-growth forest, Santa Isabel, on the Rio Negro, northern Brazil, *86;* a common plant in clearings and around villages throughout tropical America.

FLACOURTIACEAE

Lowland species

CASEARIA JAVITENSIS HBK. Santa Isabel, on the Rio Negro, northern Brazil, *999;* distributed from southern Mexico to the Amazon region.

CASEARIA SPRUCEANA Benth. Yucabí, on the Rio Negro, northern Brazil, *967*, *996*. Its type locality is at San Gabriel, where it was originally collected by Spruce; its range extends from Manáos to the Casiquiare and the upper Amazon.

LAETIA SUAVEOLENS Benth. Yucabí, on the Rio Negro, northern Brazil, *972*. The species ranges from French Guiana to the upper Amazon and the Casiquiare.

PATRISIA ACUMINATA (Eichl.) Kuntze. Yucabí, on the Rio Negro, northern Brazil, *970;* originally collected on the Rio Negro by Spruce and also reported from British Guiana.

TURNERACEAE

Lowland species

TURNERA ACUTA Willd. River banks and flood sands, Muyrapenima, on the Rio Negro, northern Brazil, *52;* Yucabí, on the same river, *969;* tropical America.

PASSIFLORACEAE[1]

Lowland species

PASSIFLORA COCCINEA Aubl. Manáos, *16*, *43;* in forest at Santa Isabel, on the Rio Negro, *97;* forest at Middle Camp, Esmeralda, *357;* widely distributed at low altitudes in the Guianas, northern Brazil, Bolivia, and eastern Peru, apparently not reported before from Venezuela.

PASSIFLORA FOETIDA L., var. **hispida** (DC.) Killip, comb. nov. *Passiflora hispida* DC. Ann. Sci. Nat. Bot. V. **17**: 172. 1873.

Yucabí, on the Rio Negro, northern Brazil, *133;* common in the American tropics and introduced into the Old World.

PASSIFLORA NITIDA HBK. In forest, Santa Isabel, on the Rio Negro, *83;* eastern Colombia to the Guianas, south in Brazil to the Amazon.

PASSIFLORA VARIOLATA Poepp. & Endl. Vine in forest, San Gabriel, on the Rio Negro, northern Brazil, *135;* previously known only from the collections of Poeppig and Spruce in northwestern Brazil.

Species of Mount Duida

PASSIFLORA SCLEROPHYLLA Harms. Flowers pink, crest of Ridge 25, 6300 ft., *521;* previously known only from Mount Roraima. The leaves of the Duida plant are proportionately broader than in typical material from Mount Roraima.

[1] By E. P. Killip.

LYTHRACEAE

Lowland species

CUPHEA SPECIOSA (Anders.) Kuntze. Right bank of the Casiquiare, above Paso del Diablo, *164;* widely distributed in the lowlands of northern South America.

LECYTHIDACEAE

Lowland species

ESCHWEILERA ELEGANS (Berg) Miers. A riverside tree at Macará, on the Rio Negro, northern Brazil, *109;* otherwise known only from the type collection at Santa Isabel.

MYRTACEAE

Lowland species

MYRCIA LANCEOLATA Camb. Santa Isabel, on the Rio Negro, northern Brazil, *82, 982, 986;* widely distributed through the Amazon Valley.

MYRCIA sp. At Santa Isabel, on the Rio Negro, *983;* a tree at edge of the river, Esmeralda, *308*. It is improbable that this species has not been described, although the specimens could not be matched in European herbaria.

EUGENIA sp. Shrub in thick forest, Preguisa, on the Rio Negro, northern Brazil, *147*. Our specimen closely resembles *E. riparia* Sagot, of French Guiana, as represented at Kew, and may actually be that species.

Species of Mount Duida

Myrcia aguitensis Gleason, sp. nov. Ramis gracilibus tenuiter sericeis mox glabrescentibus; foliis breviter petiolatis coriaceis elliptico-oblongis ad apicem linearem obtusum acuminatis, basi obtusis vel subacutis, glabris supra nitentibus utrinque reticulato-venosis; panicularum folia aequantium vel excedentium axibus compressis; hypanthio brevissime pedicellato tenuissime sericeo; sepalis punctatis, 2 late ovatis obtusis, 3 quadratis rotundato-truncatis.

Young branches slender, lightly bisulcate and very thinly sericeous, glabrescent and terete with age, the internodes 2–3 cm. long; petioles rather slender, 6–9 mm. long, channeled above, minutely pubescent with erect hairs on the upper side and subappressed hairs on the lower; blades firm or subcoriaceous, elliptic-oblong, 7–10 cm. long, 3–4 cm. wide at or just below the middle, acuminate to a nearly linear obtuse tip, obtuse or subacute at base, glabrous on both sides, shining above; lateral veins nearly straight, about 3 mm. apart, with the veinlets lightly elevated on both sides and conspicuously reticulate, the midvein plane above; panicles terminal and from the upper axils, 7 (in the

type)–10 cm. long, equaling (type) or somewhat exceeding the upper leaves, with numerous spreading branches, the axes conspicuously flattened and very thinly and minutely pubescent; flowers 5-merous, on pedicels 0.5 mm. long; hypanthium ellipsoid, about 2.5 mm. long, very thinly appressed-pubescent; sepals dimorphic, 2 broadly ovate and obtuse, 0.6 mm. long, 3 depressed-oblong, broadly rotund-truncate, 0.9 mm. long, all pellucid-punctate; staminal torus densely but minutely pubescent.

A small tree on Agüita Slope, 4000 ft., *868* (type), *871;* a tree 30 ft. high at Agüita, 3800 ft., *922*. Like the following species, it is related to *M. negrensis* Berg, differing in its more finely reticulate leaves, its more densely sericeous hypanthium rounded at the base, its shorter pedicels, and its shorter and blunter sepals. From *M. compressa* it is distinguished by its less densely pubescent stems with appressed hairs, its glabrous leaves acute at the base, its appressed-pubescent hypanthium, and its much shorter and dimorphic sepals.

Myrcia compressa Gleason, sp. nov. Ramis superne compressis dense pubescentibus; petiolis brevibus; laminis coriaceis ovato-oblongis ad apicem obtusum longe acuminatis, basi late rotundatis, utrinque reticulato-venosis, subtus tenuissime pubescentibus; paniculis amplis ramosis folia multo superantibus, axibus compressis; hypanthio ellipsoideo et sepalis ovatis dense velutinis.

Stems compressed above, becoming terete with age, closely and finely brown-pubescent, the hairs erect, 0.3 mm. long, the internodes 3–4 cm. long; petioles stout, 3–5 mm. long, pubescent like the stem; blades coriaceous, bronze-green, ovate-oblong, 12–15 cm. long, 5.5–7 cm. wide, long-acuminate to an obtuse tip, rounded at base, obscurely revolute, glabrous and shining above, very minutely puberulent beneath, the hairs less than 0.1 mm. long, denser on the veins; lateral veins straight and parallel, 4–8 mm. apart, arcuately connected near the margin, with the veinlets lightly elevated and conspicuously and closely reticulate on both sides, the midvein depressed above; inflorescence a spreading, freely branched panicle 10–20 cm. long, terminal and from the upper axils, its axes strongly ancipital and pubescent like the stem; flowers sessile on the branches or at the end of short peduncles, 5-merous; hypanthium stoutly ellipsoid, 3 mm. long, densely velutinous with short hairs; sepals spreading, broadly ovate, 2.5 mm. long and wide, obtuse, velutinous; staminal torus densely pubescent.

Woods on the Savanna Hills, 4400 ft., *834*, a small tree 20 ft. high, with very numerous whitish flowers. The species resembles *M. negrensis* Berg in habit and is undoubtedly related to it. In *M. negrensis* the leaves are acute at the base, glabrescent beneath, and much smaller in size, while the small panicles scarcely exceed the leaves.

Myrcia hirtellaefolia Gleason, sp. nov. Ramis gracilibus subteretibus breviter villosis praecipue ad nodos; foliis breviter petiolatis subnitentibus anguste oblongo-lanceolatis acuminatis basi rotundatis utrinque glabris praeter nervum medium pubescentem, venis lateralibus sub angulo recto patentibus; paniculis brevibus paucifloris villosis, bracteis compluribus ovato-lanceolatis acuminatis suffultis; hypanthio basi dense villoso, sepalis triangularibus acutis 3 exterioribus interiores 2 multo excedentibus.

Stems slender, nearly terete, persistently but thinly villous with spreading hairs 1–1.2 mm. long, more densely so at the nodes, the internodes 4–6 cm. long; petioles stout, 2–3 mm. long, pubescent like the stem; blades chartaceous, rather pale green, somewhat shining, narrowly oblong-lanceolate, 12–17 cm. long, 3.5–4 cm. wide, long-acuminate, broadly rounded at base, glabrous above or minutely pubescent along the nearly plane midvein, sparsely pilose on the midvein beneath; lateral veins barely elevated on both surfaces, spreading at nearly right angles, mostly 2–3 mm. apart, with the veinlets finely and inconspicuously reticulate; panicles mostly axillary, 2–5 cm. long, sparsely branched and few-flowered, villous like the stem; bracts numerous, ovate-lanceolate, 10–13 mm. long, rounded at base, long-acuminate, glabrous above, villous on the margin and midvein beneath, veinless above, reticulate beneath; flowers 5-merous, sessile; hypanthium obconic, 2.2 mm. long, densely villous at base with ascending hairs 1.5 mm. long, thinly pubescent above; sepals triangular, acute, densely villous, the outer 3 nearly 3 mm. long, the inner 2 about 2 mm. long; petals white.

At Agüita, 4000 ft., *913*. The species is a member of the comparatively small section *Bracteatae* Berg, and its elongate acute sepals show its relationship to *M. capitata* Berg, *M. lanceolata* Camb., and *M. involucrata* Berg. From these it differs in its larger leaves, rounded at base and with widely spreading lateral veins. Its very unequal sepals also appear to be characteristic.

MYRCIA SYLVATICA (Meyer) DC. Crests of the Savanna Hills, 4400 ft., *822;* a common species of wide distribution through northern South America.

MYRCIA sp. A plant collected at Agüita, 3100 ft., *894*, described as a vine with clustered, round, green fruits, probably belongs to this genus.

A small tree on Agüita Slope, 4000 ft., *873*, is completely sterile and may possibly be a *Myrcia* or a *Eugenia*.

MELASTOMATACEAE

Lowland species

RHYNCHANTHERA GRANDIFLORA (Aubl.) DC. Esmeralda, *239*. Widely distributed in northern South America, mostly north of the Amazon.

Acisanthera erecta Gleason, sp. nov. Caule erecto 4-alato glanduloso-villoso superne ramoso; foliis erectis vel adscendentibus subsessilibus oblongis acutis basi rotundatis 5-nerviis utrinque villosis; inflorescentia terminale paniculata multiflora; floribus 4-meris, pedicellis elongatis glanduloso-villosis; hypanthio subgloboso glanduloso; calycis lobis ovatis acutis hypanthium aequantibus; antheris subulatis uniporosis, connectivo crasso infra loculos producto basi calcaribus duabus adscendentibus ornato; ovario 3-loculare.

Stems herbaceous, 30–40 cm. high, sparsely branched below the inflorescence, densely glandular-villous; leaves sessile or subsessile, erect or ascending, exceeding the internodes, oblong, 8–12 mm. long, 3–4 mm. wide, acute, rounded at base, 5-nerved, densely villous above, densely glandular-villous beneath, especially on the nerves; inflorescence paniculate, terminal, many-flowered; flowers 4-merous, on glandular pedicels 3–10 mm. long, elongating somewhat in fruit; hypanthium subglobose, 2.5 mm. long to the sinuses, glandular-villous; sepals triangular-ovate, 2.3 mm. long, acute and setose at the tip; stamens dimorphic; filaments 2.7 or 3.5 mm. long; anthers straight, subulate, 1.5 or 2.3 mm. long excluding the connective; connective prolonged 0.6 or 0.8 mm., with two stoutly subulate erect basal spurs 0.3 or 0.5 mm. long; ovary 3-celled, minutely glandular; style 4.8 mm. long, glabrous; stigma punctiform.

Upper Grand Savanna, Esmeralda, *332*. The species is anomalous in its structure, combining the 4-merous flowers and general habit of the section *Dicrananthera* Triana with the 3-celled ovary of section *Euacisanthera* Triana.

Ernestia tenella DC. At Esmeralda, on the rocky top of Esmeralda Ridge, *198*, and on the Tree Savanna, *328*. The species is endemic to this region.

Desmocelis villosa (Aubl.) Naud. Yucabí, on the Rio Negro in northern Brazil, *992*. The species is widely distributed through central and northern South America; ours is the form distinguished by Cogniaux as variety *gracillima* Cogn.

Macairea pachyphylla Benth. On Tree Savanna at Esmeralda, *323*, *324;* previously known from the Roraima region of British Guiana.

Macairea thyrsiflora DC. On Tree Savanna at Esmeralda, *341;* known only from this general region.

Pterogastra major Triana. At San Carlos on the Rio Negro, northern Brazil, *160*, and on savannas at Esmeralda, *182*. The species ranges from Peru to Venezuela.

Tibouchina spruceana Cogn. On land subject to flood, East and West Lakes, Esmeralda, *313*. Our specimen is in imperfect condition, but differs in some notable characters from the description of the species, originally collected at Manáos. Its petals are apparently 11–12 mm. long,

instead of 20–25 mm., its filaments are 3.5 mm. long, instead of 8.5 mm., and the ovary is lepidote at the summit instead of setose. Nevertheless it agrees perfectly with the original collections of Spruce from the lower Amazon.

ACIOTIS AEQUATORIALIS Cog. At Yucabí, on the Rio Negro in northern Brazil, *973*. The species ranges through the Amazon valley from Pará to Peru.

ACIOTIS DYSOPHYLLA (Benth.) Triana. At Santa Isabel on the Rio Negro, northern Brazil, *77;* widely distributed from central Brazil to the Caribbean Sea.

ACIOTIS LAXA (L. C. Rich.) Cogn. In forest at Santa Isabel on the Rio Negro, northern Brazil, *93;* an abundant plant in the lowlands of northern Brazil and the Guianas.

ACIOTIS PURPURASCENS (Aubl.) Triana. In forest at Santa Isabel on the Rio Negro, northern Brazil, *103*. The species is common and widely distributed throughout northern South America.

ACANTHELLA CONFERTA (Vell.) Cogn. On the rocky top of Esmeralda Ridge, the flowers "flame-orange," *197;* endemic to this station so far as known, where it was first collected by Bonpland.

OPISTHOCENTRA CLIDEMIOIDES Hook. f. A shrub in the forest at San Gabriel, on the Rio Negro in northern Brazil, *137*, the type locality and only known station.

MICONIA ALBICANS (Sw.) Triana. Among sandstone rocks at Esmeralda, *177;* common and widely distributed from Bolivia to Cuba and Mexico.

MICONIA APLOSTACHYA (Bonpl.) DC. Riverside at Macará, on the Rio Negro, northern Brazil, *111;* distributed through the northern Amazon Valley and the Guianas.

MICONIA ARGYROPHYLLA DC. In forest at Tinahy on the Rio Negro, northern Brazil, *116*. The species ranges through tropical South America from São Paulo to the Caribbean Sea.

MICONIA STENOSTACHYA DC. Tree Savanna at Esmeralda, *322;* widely distributed from Bolivia to Mexico.

MICONIA sp. At Esmeralda, *312*. The specimen lacks flowers; in foliage it resembles several large-leaved species of the section *Eumiconia Paniculares* Naud. and probably agrees better with *M. panicularis* Gleason than any of the others.

TOCOCA GUYANENSIS Aubl. On river banks and flood sands at Muyrapenima on the Rio Negro, northern Brazil, *70;* widely distributed through the lowlands of central and northern South America.

TOCOCA NITENS (Benth.) Triana. At Esmeralda, *241*. The species is known from the sandstone regions of Venezuela and British Guiana and reappears in central Brazil.

CLIDEMIA AFFINIS (Naud.) Cogn. Yucabí, on the Rio Negro, northern Brazil, *993, 994;* northern Brazil and British Guiana.

CLIDEMIA BISERRATA DC. At Muyrapenima on the Rio Negro in northern Brazil, *51;* at Buena Vista on the Rio Casiquiare in Venezuela, *158*. As here interpreted, the species is of wide distribution in tropical South America and includes a variety of forms which have often been considered distinct species.

CLIDEMIA HIRTA (L.) D. Don. Yucabí, *997*, and Santa Isabel, *80*, on the Rio Negro in northern Brazil; at Caxoeira San Sebastian on the Rio Casiquiare in Venezuela, *153*. It is a common plant from southern Brazil as far north as Cuba and Mexico.

CLIDEMIA NAEVULA (Naud.) Triana. In forest at Tinahy, on the Rio Negro in northern Brazil, *114*, and at Yucabí, *1000*. The species is limited to the northern Amazon valley and the Guianas.

Henriettella micrantha Gleason, sp. nov. Ramis juvenilibus pilis ferrugineis dense strigosis; foliis petiolatis ovato-oblongis acuminatis basi rotundatis vel subcordatis sub-5-plinerviis, supra sparse breviterque strigosis mox glabrescentibus, ad venas venulasque impressas dense strigosis, subtus pilosis pilis ferrugineis ad basin stellatis; floribus 6–10 fasciculatis sessilibus, 5-meris; hypanthio campanulato breve sparse ferrugineo-strigoso; calycis lobis brevibus late rotundatis; petalis brevibus obtusis; antheris linearibus non rostratis; stylo glabro.

Stems woody, when young densely strigose with ferruginous hairs 1–1.5 mm. long from somewhat papillose bases, becoming glabrous with age; petioles stout, 10–15 mm. long, strigose like the stem; blades subcoriaceous, ovate-oblong, sharply acuminate, rounded or subcordate at base, entire, 5-pli-nerved, the outer pair weak and marginal; secondaries mostly 5–8 mm. apart, spreading at nearly right angles, with the primaries impressed above, elevated beneath, the tertiaries finely reticulate; upper surface sparsely pilose when young with ferruginous hairs from stellate bases, nearly 1 mm. long and set about the same distance apart, soon deciduous, the primaries densely and permanently strigose; lower surface pilose with similar hairs about 0.5 mm. apart, both primaries and secondaries strigose; flowers 5-merous, sessile, in fascicles of 6–10

in the lower axils and at the leafless nodes; hypanthium campanulate, 3.7 mm. long to the torus, freely punctate and conspicuously strigose with curved-ascending hairs; calyx about 0.7 mm. long, pubescent like the hypanthium, its lobes obscure, broadly rounded; petals white, ovate-oblong, obtuse, 3 mm. long; filaments slender, 4 mm. long, abruptly contracted and slightly bent 0.8 mm. from the summit; anthers stoutly linear, 2.7–3 mm. long, rounded at the summit, with a dorso-terminal pore; connective prominently thickened on the basal two thirds of the anther, neither appendaged nor prolonged; ovary wholly inferior, 5-celled; style stout, nearly straight, 8 mm. long, slightly thickened distally to the truncate stigma.

New Savanna at Esmeralda, *953*. The species is apparently related to *H. Seemannii* Naud. of Panama and *H. Goudotiana* of Colombia, differing from the former in its obtuse petals and entire leaves essentially glabrous on the upper side, and from the latter in its 5-merous flowers and the absence of squamulose pubescence.

Species of Mount Duida

Poteranthera duidae Gleason, sp. nov. Caule pusillo herbaceo ramoso; foliis anguste oblongis acutis basi in petiolum alatum angustatis glabris 1-nerviis; floribus solitariis caulem et ramulos axillares terminantibus pedicellatis 4-meris; hypanthio campanulato glanduloso-villoso; sepalis hypanthio paullo longioribus acuminatis glandulosis; petalis obovatis; staminibus 4; antheris ellipsoideis erostratis; connectivo crasso antheram aequante, in articulatione filamenti antice crasse bicalcarato; ovario libero 2-loculare; stigmate capitellato.

A bushy, freely branched herb 10 cm. high, the stems spreading, prominently strigose with loose hairs 0.5–0.8 mm. long, usually somewhat longer at the nodes, in age becoming thinly strigose or glabrate; internodes 2–5 or at the base of the stem 8 mm. long; petioles flat, narrowly winged, 0.5 mm. long, strigose on the back; leaf-blades lance-oblong to linear-lanceolate, 3–6 mm. long by a third to a fourth as wide, acute or subobtuse at both ends, obscurely 1-nerved, glabrous, or very sparsely strigose beneath; flowers 4-merous, solitary, terminal on the stem and its short axillary branches; pedicels 5–6 mm. long, strigose like the stem and often glandular; hypanthium campanulate, 2 mm. long to the sinus, freely villous with glandular hairs; calyx-tube not prolonged; sepals spreading, ovate-lanceolate, 2.4 mm. long, acuminate, sparsely glandular-hirsute and irregularly ciliate; petals magenta, obovate, 3.3 mm. long; stamens 4, episepalous; filaments erect, 3.3 mm. long; anthers stoutly ellipsoid, nearly 1 mm. long, with a bare indication of a terminal tube; connective 0.8 mm. long, stout, prolonged ventrally into 2 large, fleshy, somewhat spreading, strongly ascending, rounded lobes; ovary superior, obovoid, 1.5 mm. long, 2-celled; style terete, 4.3 mm. long, tapering above to a flat capitellate stigma.

On rocks in the streambed at Central Camp, 4800 ft., *550*. It is a member of the section *Tulasnea*, as indicated by its 4-merous flowers and 2-celled ovary, and differs from other members of the section in the large connective, which is as long as the pollen-sacs and twice as bulky, as well as in various other structural details.

Macairea duidae Gleason, sp. nov. Fruticosa; caule pilis arcte appressis basi ellipsoideo-incrassatis persistenter et dense obtecto; petiolis brevissimis; laminis parvis obovato-oblongis vel late ellipticis utrinque rotundatis 3-nerviis supra scaberrimis subtus ad venas dense crasseque strigosis inter venas reticulatas pubescentibus; panicula parva strigosa; pedicellis et hypanthio hirsutis; capsula 4-loculare scabrida superne glandulosa.

Stem rather stout, terete, densely covered with closely appressed hairs with dilated ellipsoid bases terminated by a slender tip, the internodes 2–3 cm. long; petioles stout, 3–5 mm. long, pubescent like the stem; blades firm, drying brownish-green, obovate to obovate-oblong or elliptic, 35–40 mm. long, 25–28 mm. wide, broadly rounded at both ends, 3-nerved with an additional obscure marginal pair; veins lightly impressed above, prominent beneath, the veinlets 2 mm. apart, ascending at an angle of 45°; upper surface very scabrous with short, broadly conic hairs; lower surface densely strigose with stoutly subulate hairs on the primaries and secondaries, pubescent with erect hairs on the surface and on the closely crowded tertiaries; panicle small, 5–6 cm. long, loosely strigose below, the hairs elongating distally and becoming hirsute on the pedicels; hypanthium (in fruit) ellipsoid, hirsute; capsule 4-celled, scabrous, glandular at the summit.

Savanna Hills, 4400 ft., *1024*. The plant has a general resemblance to *M. radula* (Bonpl.) DC. but is more nearly related to *M. rigida* Benth., collected in the same locality, which differs greatly in its pubescence.

Macairea lanata Gleason, sp. nov. Arbuscula; caule obscure 4-angulato villoso ad nodos longissime villoso; foliis subsessilibus quam internodis 3-plo longioribus oblongo-lanceolatis apice acutis vel obtusis, glanduloso-ciliatis, basi rotundatis 5-nerviis, venis lateralibus marginalibus, supra papillis setiferis dense obtectis, subtus reticulatis, foveolatis, densissime pubescentibus, ad venas longe villosis; inflorescentia parva folia vix excedente pedicellis glanduloso-villosis; floribus 4-meris; hypanthio campanulato 8-costato, glanduloso-hirsuto; calycis lobis oblongo-triangularibus acutis glanduloso-hirsutis; petalis apice glandulosis; filamentis glabris; connectivo gracile longe producto basi cordato explanato; ovario 3-loculare apice glanduloso; stylo glabro.

A shrub 2–3 feet tall; stem densely villous with brown, partly glandular hairs, the nodes more densely villous with hairs 4–7 mm. long, the internodes 10–15 mm. long; leaves firm, spreading or deflexed, subsessile, oblong-lanceolate, as much as 50 mm. long by 22 mm. wide, obtuse or acute, minutely ciliate with slender glandular hairs, rounded at base, 5-nerved, the lateral pair

marginal; upper surface densely covered with contiguous ovoid papillae bearing a terminal simple hair 2–4 mm. long; lower surface finely reticulate, foveolate, densely pubescent, the veins villous; inflorescence 2–4 cm. long, few-flowered, barely exceeding the leaves, glandular-hirsute; flowers 4-merous, on pedicels 8–15 mm. long; hypanthium campanulate, prominently 8-ribbed, 4 mm. long, densely glandular-hirsute, the hairs increasing distally to 3 mm. in length; staminal torus projecting as 8 minute rounded lobes; calyx-tube erect, prolonged about 0.5 mm.; sepals oblong-triangular, 3.2 mm. long, acute, glandular-hirsute on the back and the distal half of the front; petals pink-magenta, broadly elliptic, 11 mm. long by 7 mm. wide, slightly inequilateral, tipped with a few glandular setae as much as 1 mm. long, glandular-ciliate; stamens dimorphic, glabrous throughout; filaments 6 or 9.5 mm. long; anthers 4–5 mm. long; connective slender, terete, 1.5 or 3.5 mm. long, thickened at base into a cordate organ surrounding the summit of the filament; ovary free, ovate-ellipsoid, 3.2 mm. long, densely glandular on the distal fourth, 3-celled; style glabrous, 13 mm. long.

Moist slopes of Savanna Hills, 4400 ft., *752;* Brocchinia Hills, 4500 ft., *588* (type). Under Cogniaux' artificial arrangement, our species would seem related to *M. rigida* Benth. and *M. parvifolia* Benth., both of the Mount Roraima region. In the former, however, the connective is short and stout; in the latter the filaments are glandular. It is, in fact, much more closely related to *M. multinervia* Benth., also from Roraima, which combines the slender connective with glabrous filaments. It differs from that species in its larger hypanthium with longer hairs, acute sepals, larger petals and stamens, thicker appendage on the connective, more pubescent ovary, much longer style, larger and narrower acute leaves, reduced inflorescence, much shorter internodes, and densely villous nodes.

Macairea linearis Gleason, sp. nov. Arbuscula; caule superne adpresse lepidoto; petiolis brevibus lepidotis; foliis rigidis linearibus, utrinque obtusis vel subacutis, revolutis, 3-nerviis, supra glabris rugosis, subtus minute foveolatis ad venas marginemque lepidotis; inflorescentia breve terminale 3-flora; floribus 4-meris breviter pedicellatis; hypanthio parvo 8-costato basi sublepidoto apice glanduloso-piloso; calycis lobis lineari-lanceolatis hypanthium excedentibus; petalis obovato-ellipticis; filamentis glandulosis; connectivo producto basi incrassato; ovario libero 3-loculare superne lepidoto et apice glanduloso; stylo glanduloso.

A shrub 3 feet tall; stem densely scaly above with whitish lancoid appressed scales, the cortex and indument exfoliating about 10 cm. from the summit, the internodes about 3 mm. long, the nodes somewhat swollen and with an annulus of several longer scales; petioles 3 mm. long, lepidote like the stem; leaf-blades stiff and firm, dark green, linear, 12–18 mm. long, 2–2.5 mm. wide, obtuse or acute at both ends, 3-nerved; upper surface glabrous and rugose, the

primaries lightly impressed; lower surface foveolate, the margins and primaries lepidote; inflorescence a 3-flowered terminal cluster, scarcely exceeding the upper leaves; bracts linear-spatulate, 5–6 mm. long; pedicels lepidote, about 5 mm. long; flowers 4-merous; hypanthium campanulate, about 2.5 mm. long to the torus, with 8 rather prominent purple-red ribs, sublepidote below with lancoid or conic scales, which above become more spreading and more slender and glandular at the tip; calyx-tube prolonged 0.5 mm.; sepals linear-lanceolate, more or less spreading, 3.5 mm. long; petals obovate-elliptic, magenta, 10.5 by 6.5 mm.; staminal torus unlobed; filaments stout, terete, 3.7 or 4.4 mm. long, glandular throughout, especially distally and on the inner face; anthers almost straight, subulate, 2.5 mm. long; connective stout, terete, prolonged 0.5 or 0.9 mm. and expanded at base into a fleshy cordate organ surrounding the summit of the filament; ovary free, 4-ribbed, 3-celled, pubescent above the middle with stout conic hairs becoming more numerous above and concealing the summit, where most of them are glandular; style 6.4 mm. long, sparsely glandular throughout (Pl. 35, fig. 1).

In the stream-bed at Central Camp, 4800 ft., *532*. Among the twenty or more species of *Macairea*, this one is unique in its small linear leaves. Under the artificial arrangement of species in Cogniaux' Monograph, it would be related to such species as *M. thyrsiflora* DC., collected on this expedition at Esmeralda, but the two are entirely unlike in habit and in many details of structure.

MACAIREA RIGIDA Benth. A bush with brittle twigs and pink flowers, on crest of ridge, Savanna Hills, 4400 ft., *769*. The species is known only from the Pacaraima Mountains, where it was originally collected by Schomburgk, and may be expected at suitable altitudes between Roraima and Duida.

TIBOUCHINA FRATERNA N. E. Brown. A plant 1–2 feet high on dry ridge-top, Savanna Hills, 4400 ft., *796;* a bush 2–3 feet high with pink flowers, crest of Ridge 25, 6300 ft., *454;* on summit of Peak 7, 7100 ft., *634*. The species has hitherto been considered endemic to Mount Roraima.

MARCETIA TAXIFOLIA (St. Hil.) DC. In dry laterite soil, Savanna Hills, 4400 ft., *784;* among rocks, summit of Peak 7, 7100 ft., *672;* well distributed through central and southern Brazil and also known from Mount Roraima.

ADELOBOTRYS sp. A vine at Agüita, 4000 ft., *911*. The specimen is in fruit. The hypanthium is conspicuously ribbed, with a flaring truncate calyx bearing filiform exterior teeth half a millimeter long; the capsule is 5-celled; the seeds are linear, truncate at one end, 1.5–1.8 mm. long. It is probably related to *A. rotundifolia* Triana, collected at low altitudes on the Rio Casiquiare.

Meriania duidae Gleason, sp. nov. Frutex humilis; foliis crasse coriaceis ovato-ellipticis apice rotundatis vel subacutis basi rotundatis integris 5-nerviis supra scaberrime strigosis et juventute lanatis, subtus ad venas venulasque dense lanatis; inflorescentia breve umbelliformia pedunculata pauciflora densissime lanata; floribus 5-meris breviter pedicellatis; hypanthio campanulato; sepalis late ovatis rotundatis dense lanatis; antherarum majorum connectivo postice appendicem apice bilobam, minorum simplicem oblongam gerente; ovario libero 3-loculare; stylo basi hirsuto; stigmate punctiforme.

Stems woody, 4 feet high, when young closely ferruginous-tomentose and sparsely hirsute, glabrescent with age, the principal internodes 2–3 cm. long; petioles stout, channeled above, 3–10 mm. long, densely strigose or subtomentose; leaf-blades coriaceous, ovate-oblong to ovate-elliptic, 3.5–5 cm. long, 2–3 cm. wide, subacute to broadly rounded at the apex, entire, rounded at base, 5–7-nerved, the outer pair usually obscure and submarginal, the secondaries obscure above, prominent beneath, spreading at nearly right angles, about 2 mm. apart, tertiaries not visible; upper surface densely and scabrously strigose with stout hairs nearly 2 mm. long, set 0.6–0.8 mm. apart, also thinly woolly when young; lower surface proper glabrous, the primaries and secondaries densely lanate and conspicuously hirsute with brown hairs; inflorescence umbellate or subcapitate, terminal, densely woolly to the tips of the sepals with brown matted hairs 2–3 mm. long, the peduncle 1–2 cm. long, the pedicels 2–6 mm. long; flowers 5-merous; hypanthium campanulate, 4 mm. long to the torus, rather fleshy in texture; calyx-tube prolonged 2 mm., the sepals broadly ovate, 4 mm. long, rounded at the summit, thickened at the middle to a completely adnate exterior tooth, thinner and ciliate at the margin; petals pink, cuneate-obovate, 16 mm. long, 10 mm. wide, very inequilateral, freely nerved; small stamens: filaments flat, 9.5–10.5 mm. long; anthers subulate, strongly deflexed, somewhat extrorsely curved, about 3.7 mm. long; connective prolonged at base to a short conic basal spur 0.8 mm. long and bearing a linear dorsal spur 1.8 mm. long ascending at an angle of 70° from the anther; large stamens: filaments flat, 7.6–8.6 mm. long; anthers subulate, strongly extrorsely curved, 7–8 mm. long; connective prolonged at base into a short conic basal spur and bearing a dorsal spur 2.2 mm. long, broadened and 2-lobed at the end; ovary wholly free, obconic, glabrous, 2.8 mm. long, excavate at the summit, 3-celled; style nearly straight, 9 mm. long, slightly bent near the summit to a punctiform stigma, freely hirsute over the basal two thirds.

Slopes of Ridge 25, 5500–6000 ft., *403* (type); summit of Peak 7, 7100 ft., *633*. We have here a species differing remarkably from other members of the genus in its general habit. It seems to be a member of the section *Adelbertia* Naud., but differs from the other species in its low stature, its exceedingly heavy pubescence, its hairy style, and its strongly dimorphic stamens. The description has been compiled wholly from the

type;[1] the second specimen differs in several minor particulars. The pubescence is cinerous rather than brown, the leaves have one less pair of veins, the peduncle is 2–5 cm. long, and the whole plant is lower, giving evidence of reclining in the matted vegetation, rooting along the covered parts of the stem, and sending up its flowering branches to a height of only 2–3 dm.

GRAFFENRIEDA OVALIFOLIA Naud. A tall shrub at Agüita, 3100 ft., *931;* a "dusty looking bush" on the dry crests of Savanna Hills, 4400 ft., *739.* The species has hitherto been considered endemic to the region of Mount Roraima; by some authors it has been united with *G. Weddellii* Naud. of southern Brazil.

Graffenrieda polymera Gleason, sp. nov. Caule superne obscure 4-angulato, dense purpureo-brunneo furfuraceo; foliis crasse coriaceis, breviter petiolatis, late ellipticis vel ovatis superioribus angustioribus, acutis vel breviter apiculatis, integris subrevolutis, basi rotundatis, 3-nerviis nervis lateralibus ad marginem proximis, supra flavescentibus glabris rugulosis, subtus ferrugineis dense tomentosulis; inflorescentia terminale pauciramosa dense furfuracea, floribus ad apicem ramorum capitatis 5–8-meris; hypanthio obconico dense furfuraceo; calyce vix lobato; petalis late ellipticis; filamentis complanatis; antheris subulatis; connectivo basi in calcar erectum subulatum producto; ovario 3-loculare.

A shrub 15 feet tall; stem stout, obscurely 4-angled above, densely but minutely furfuraceous, purple-brown, the internodes 2–3 cm. long; petioles stout, pubescent like the stem, 10–15 mm. long; leaf-blades thick, coriaceous, broadly elliptic or ovate, as much as 13 cm. long by 8.5 cm. wide, the upper somewhat narrower in outline and subacute, the lower rounded to a subacute apiculum, all entire and revolute, rounded at base, 3-nerved, the outer pair submarginal, the secondaries obscure above, prominent beneath, not extending outside the lateral nerves; upper surface yellowish green, glabrous, rugulose; lower surface ferruginous, densely tomentulose; inflorescence terminal, long-peduncled, 1–2 dm. long, brown-furfuraceous, the single central node bearing two lateral branches, subtended by two sessile flowers or two short branches, and a terminal internode; flowers capitate at the end of the branches, subsessile, 5–8-merous in the same inflorescence; hypanthium obconic, including the calyx 14 mm. long and densely red-brown furfuraceous; calyx-tube prolonged 4 mm. beyond the torus, scarcely lobed, the lobes minutely subapiculate; petals pink, broadly elliptic, 17 mm. long, 10 mm. wide; filaments flat, glabrous, 7 mm. long, all deflexed to one side of the flower; anthers subulate, 8.5 mm. long, nearly straight, the pollen-sacs much convoluted; connective

[1] This is a plant of the crest vegetation of the promontories. Its habit is sturdy and rigid and it is commonly seen scattered somewhat widely among the cushiony vegetation of those places.—G. H. H. T.

thickened toward the base of the anther and prolonged below it into a straight erect subulate appendage 2 mm. long; ovary free, truncate-conic, 3-celled; style strongly deflexed, slender, 17 mm. long; stigma punctiform.

Crest of Ridge 25, 6300 ft., *401* (type); summit of Peak 7, 7100 ft., *620*. The latter specimen has smaller leaves and is in bud. Our species is related to *G. rotundifolia* (Bonpl.) DC. and *G. caryophyllea* Triana, the former of Venezuela, the latter from the Rio Negro. It differs from both of them in its wider leaves and flowers which are much larger in all dimensions, essentially sessile, and often with six to eight petals.

Graffenrieda tricalcarata Gleason, sp. nov. Arborescens; ramis acute quadrangularibus subglabrescentibus; foliis petiolatis elliptico-ovatis longe obtuseque acuminatis integris basi obtusis 5-nerviis subtus ab basin venarum majorum hirsutis ceterum glabris; inflorescentia paniculata longe pedunculata ramis verticillatis multiflora; floribus 5-meris brevissime pedicellatis; hypanthio parvo hemispherico 5-costato albido-pulverulento; sepalis late triangularibus acutis; petalis lanceolatis longissime acuminatis; filamentis brevibus complanatis; antheris subulatis; connectivo breviter producto basi in appendices 2 laterales conicas et centralem subulatam apice 2–4-fidam abeunte; ovario libero ovoideo dense pulverulento apice 5-setoso; stigmate truncato; capsula albida 3-loculare.

A slender tree 20 feet high, the branches sharply 4-angled and very sparsely pulverulent when young, becoming terete and glabrous with age, the upper internodes 2–3 cm. long; petioles slender, 2–3 cm. long, glabrous; leaf-blades membranous, ovate-elliptic, 5–9 cm. long by half as wide, acuminate to an obtuse tip, entire, obtuse or subrotund at base, 5-nerved with an additional obscure marginal pair, secondaries obscure; both surfaces sparsely pulverulent when young; soon becoming glabrous, the three principal primaries conspicuously hirsute at their base beneath; inflorescence terminal, panicled, the peduncle (5 cm. long) and the verticillate branches sharply 4-angled, essentially glabrous; flowers 5-merous, on pedicels 1 mm. long; hypanthium subhemispheric, 1.5 mm. long to the torus, prominently 5-angled, densely whitish-pulverulent; calyx-tube prolonged 0.3 mm., the sepals strictly erect, broadly triangular with concave sides 0.5 mm. long, thickened at the apex; petals lanceolate, 5–5.5 mm. long, 2 mm. wide, long-acuminate; stamens isomorphic; filaments stout, flat, 1.5 mm. long; anthers subulate, 2 mm. long to base of pollen sacs, somewhat extrorsely curved, opening by a dorso-terminal pore; connective prolonged 0.3 mm. to the summit of the filament, thence produced into 2 conic lateral appendages 0.2–0.3 mm. long and 1 central appendage 0.7 mm. long, 2–4-fid at the tip; ovary free, ovoid, densely pulverulent, the summit slightly prolonged and bearing about 5 stout bristles 0.6–1.4 mm. long; style slender, 6 mm. long; stigma truncate; capsule 3-valved, white-pulverulent, exceeding the sepals.

On the slopes of Mount Duida at Agüita, 4000 ft., *908*. Our plant finds its nearest relative in *Graffenrieda patens* Triana, a lowland species of the same general region. The latter has leaves prominently reticulate above, puberulent beneath, and 5-nerved, much longer sepals, and a 5-celled ovary.

A sterile plant collected in dry laterite soil on the Savanna Hills, 4400 ft., *788*, is possibly a *Graffenrieda* and related to *G. sessilifolia* Triana, of Mount Roraima. It has coriaceous, shining subsessile, ovate leaves, cordate-clasping at base, and abruptly and obtusely short-acuminate.

Macrocentrum glandulosum Gleason, sp. nov. Tota planta ad calycem glandulosa, glandulis subglobosis sessilibus rubris nitentibus; caule herbaceo pusillo ramoso; foliis petiolatis late ellipticis plerumque utrinque rotundatis ciliatis obscure 3-nerviis, inflorescentia ex axillis superioribus racemosa pauciflora; floribus 5-meris breviter pedicellatis; hypanthio anguste obconico valde 10-costato; sepalis triangulari-ovatis acuminatis persistentibus; capsula anguste prismatica hypanthium aequante apice retusa 3-loculare; seminibus semiobovoideis.

Herbaceous, 10 cm. high; whole plant to the calyx more or less densely covered with subglobose, sessile, shining, red glands, most abundantly on the petioles, most sparsely on the leaf-surface; petioles slender, 5–10 mm. long; leaf-blades thin, opaque, essentially isophyllous, broadly elliptic, as much as 17 by 11 mm., usually broadly rounded at both ends, occasionally subacute and very broadly cuneate at base, strongly ciliate with curved-ascending hairs, both surfaces smooth and glabrous except for the sparse glands; inflorescence racemose from the upper axils, the peduncles as much as 5 cm. long but mostly shorter, bearing 1–4 distal 5-merous flowers on pedicels 2–5 mm. long; hypanthium narrowly obconic, in fruit strongly 10-ribbed and with the persistent sepals 10 mm. long; sepals triangular-ovate, in fruit 3.2 mm. long, acuminate, glabrous, 3-nerved, glandular on both sides; capsule narrowly prismatic, equaling the hypanthium, retuse at the summit, 3-celled; seeds numerous, semiobovoid, 0.6 mm. long.

Cañon of Rio Negro, Savanna Hills, 4400 ft., *760*. Although flowers are lacking, there can be no doubt of the generic position of this little plant. It differs from *M. gesneriaceum* Sandwith in its isophylly and leaf-shape, from *M. droseroides* Triana and *M. vestitum* Sandwith in its indument, from *M. cristatum* (L. C. Rich.) Triana in its 5-merous flowers, from *M. fasciculatum* (DC.) Triana in the size and shape of its leaves; from all five in the shape of its sepals and its glandular indument.

Macrocentrum pusillum Gleason, sp. nov. Caule herbaceo 4-angulato glabro sparse glanduloso isophyllo; petiolis elongatis anguste alatis glandulosis; foliorum laminis ovato-lanceolatis obtusis vel subacutis supra medium

insigniter spinuloso-denticulatis basi cuneatis 1-nerviis, supra glabris, subtus glanduloso-punctatis; floribus solitariis terminalibus, pedicellis 10-costatis; hypanthio obconico glabro 10-costatis costis alternis a lobis rotundatis terminatis, alternis in sepala abeuntibus; sepalis ovatis acuminatis; connectivo postice appendice crasso apice dilatato instructo.

Stems herbaceous, 5–10 cm. high, 4-angled, glabrous, sparsely glandular-punctate, the internodes 3–5 mm. long; leaves essentially equal in each pair; petioles 5–8 mm. long, narrowly winged, sparsely glandular-punctate; blades thin, ovate-lanceolate, as much as 18 mm. long by 6 mm. wide, obtuse or subacute, cuneate at base, conspicuously spinulose-denticulate above the middle, dark green and glabrous above, gray-green and glandular-punctate beneath, strictly 1-nerved; flowers 5-merous, solitary, terminal; pedicels 6 mm. long, slender, strongly 10-costate; hypanthium obconic, 2.5 mm. long, glabrous, with 10 prominent, rounded, nearly contiguous ribs, the epipetalous ribs expanded at the summit into projecting rounded lobes, the episepalous ribs widened at the summit to the width of the sepal-base and continued into the sepal; calyx-tube prolonged 0.5 mm., the sinuses triangular, broadly acute; sepals ascending, ovate, 3 mm. long, 1.8 mm. wide, acuminate, the margins thin and membranous, the center thick but flat, continuing the ribs of the hypanthium; petals deep pink, 4.3 mm. long, broadly elliptic-ovate, obtuse, freely veined; stamens 10, isomorphic; filaments 3 mm. long, flat, thin and scarious, 1-nerved, tapering to the summit; anthers subulate, gently arcuate, 2.4 mm. long, opening by a minute dorso-terminal pore; connective prolonged below the pollen-sacs 0.4 mm. to the summit of the filament and thence into a dorsal appendage, 1.3–1.6 mm. long, stout and terete below, expanded distally into a flat elliptic tip 0.4 mm. wide; ovary superior, prismatic, 2 mm. long, 3-celled, retuse at the summit; style straight, 3 mm. long, scarcely narrowed to the punctiform stigma.

On a mossy tree-trunk, valley beyond Ridge 23b, 5950 ft., *478*. The species is distinguished from the other members of the genus by its singular appendage, which greatly resembles that of a *Monochaetum*. It is possibly related to *M. glandulosum* Gleason, the flowers of which have not been seen but which is similarly glandular-punctate. In the present species the glands are much fewer and less conspicuous on all parts of the plant except the under surface of the leaves and the upper side of the sepals, where two areas of them appear, one on each side of the sepal at its very base.

The seven species of this little genus are distributed, so far as known, over the Guianas, northern Brazil, and southern Venezuela, and are poorly represented in herbaria. Because of their small size they are easily overlooked by collectors among the wealth of taller plants. They may be distinguished as follows:

Flowers 5-merous.
  Sepals depressed-semicircular, obtuse *M. fasciculatum* (DC.) Triana.
  Sepals ovate or triangular-ovate, acuminate.
    Leaves broadly elliptic, obtuse at both ends, 3-nerved *M. glandulosum* Gleason.
    Leaves ovate-lanceolate, acute at both ends, 1-nerved *M. pusillum* Gleason.
Flowers 4-merous.
  Flowers on naked elongate peduncles *M. droseroides* Triana.
  Flowers in axillary or terminal short racemes.
    Leaves strongly anisophyllous, apparently alternate *M. gesneriaceum* Sandwith.
    Leaves equal or slightly anisophyllous, opposite.
      Leaves densely setose on both sides *M. vestitum* Sandwith.
      Leaves sparsely setose or glabrous *M. cristatum* (L. C. Rich.) Triana.

Tateanthus Gleason, gen. nov.

Flores quinquemeri. Hypanthium conico-obovoideum late 5-alatum. Sepala triangularia adscendentia persistentia apice subulata. Petala flava mediocria oblongo-obovata retusa. Stamina 10 isomorphia; filamentis erectis leviter extrorse curvatis minute glandulosis; antheris deflexis ovoideis apice in rostrum sigmoideum uniporosum productis, connectivo infra loculos non producto inappendiculato. Ovarium inferum 5-loculare apice exsculptum 5-loculare. Stylus teres leviter curvatus glandulosus, stigmate punctiforme. Fructus capsularis loculicide apice dehiscens. Semina numerosa fusiformia, placentis centralibus.

Flowers 5-merous. Hypanthium conic-obovoid, broadly 5-winged. Sepals triangular, ascending, persistent, subulate at the apex. Petals yellow, medium in size, oblong-obovate, retuse. Stamens 10, isomorphic. Filaments erect, slightly curved extrorsely, minutely glandular-pubescent. Anthers deflexed, ovoid, prolonged into a short sigmoid beak, opening by a single terminal pore; connective neither prolonged nor appendaged. Ovary wholly inferior, 5-celled, the summit roundly 5-lobed, depressed in the center. Style terete, slightly curved, minutely glandular-pubescent; stigma punctiform. Fruit a loculicidal capsule. Seeds narrowly fusiform, numerous, on axial placentae.

Tateanthus duidae Gleason, sp. nov. Arbuscula vel frutex; ramis junioribus dense brunneo-tomentosis vetustioribus glabris; foliis subcoriaceis breviter petiolatis ellipticis vel late ovatis, obtusis vel rotundatis, integris, 5-pli-nerviis, supra opace viridibus rugulosis glabris, subtus ferrugineis insigniter reticulatis minute et dense tomentulosis; cymis amplis rotundatis e basi ramosis ad nodos incrassatos subsessilibus tomentosulis, pedicellis filiformibus; hypanthio minute glanduloso; petalis supra puberulentibus.

A shrub; the upper branches terete, deep brown, densely and finely tomentulose, becoming glabrous in age, the internodes as much as 11 cm. long; petioles stout, 8–12 mm. long, narrowly channeled above, tomentulose like the stem; leaf-blades subcoriaceous, elliptic or broadly ovate, as much as 8 by 5 cm., the upper smaller, obtuse or rounded at apex, entire, obtuse to rotund at base, 5-pli-nerved with an obscure additional marginal pair, the secondaries

obscure above, prominent beneath, crooked and often branched, spreading at nearly right angles, with the tertiaries conspicuously reticulate; upper surface opaque, dull green, glabrous, minutely rugulose; lower surface brownish green, very minutely but densely tomentulose; inflorescence cymose, broadly rounded, 6–10 cm. long, subsessile, freely branched from the base, brown-tomentulose like the stem, the lower swollen nodes subtended by foliaceous bracts 4–1 cm. long resembling the foliage leaves, the upper bracts linear, soon deciduous; pedicels thinly glandular-puberulent, filiform, 8–14 mm. long; hypanthium at anthesis 5 mm. long, minutely glandular-pulverulent, its salient wings gradually widened from the base to 0.8 mm. above the center, thence somewhat narrowed to the base of the sepals; calyx-tube not prolonged beyond the torus; sepals 2.2 mm. long from rounded sinuses, minutely and softly puberulent throughout, gradually thickened along the midvein above the middle to a somewhat cucullate apex; petals 7 mm. long by 4 mm. wide, inequilateral, slightly retuse, cuneate to the base, glabrous on the back, very minutely puberulent on the face; filaments stout, somewhat flattened, 3–3.6 mm. long, their glandular pubescence decreasing distally above and absent from the summit; anthers 1.75–2 mm. long, rounded at base, opening by a single ventro-terminal pore; style stout, terete, slightly curved, 4 mm. long, gradually tapering to the punctiform stigma, the basal four fifths minutely glandular; fruiting hypanthium almost globose, 6.5 mm. long, the wings firm in texture; distal wall of the capsule incurved between the sepals, producing 5 rounded beaks meeting in the middle, the concavities overarched by portions of the staminal torus (Pl. 34).

On Agüita Slope, 4000 ft., *1029*, in fruit; at Central Camp, 4800 ft., in flower, *1028* (type); on the crest of First Ridge, 5000 ft., *475*, in flower. We find in this plant a number of structural characters which separately are well known in the family, such as an umbelliform inflorescence, strongly winged hypanthium, rostrate anthers, completely simple connective, wholly inferior ovary, and dehiscent capsular fruit. In each of these features it resembles one or more established genera, but in their remarkable combination it differs so widely from all others that the tribe to which it belongs remains an open question. In the character of the ovary and fruit it is apparently related to the *Sonerileae* and *Bertolonieae*, the former paleotropic, the latter American, and rather poorly differentiated from each other. In its 5-celled ovary it suggests the Old World group and also agrees with it better in general habit.

It is entirely fitting to dedicate this extraordinary genus to Mr. G. H. H. Tate, without whose personal interest and energy the flora of Duida would still be completely unknown.

Leandra linearis Gleason, sp. nov. Affinis *Leandrae nervosae* (Naud.) Cogn.; caule sparse stellato, inflorescentia sparse hirsuta, hypanthio sub-

glabro, foliis linearibus 3-nerviis non reticulatis nec bullatis subtus ad venas tenuiter et minute strigosis ceterum glabris, floribus 4-meris.

A bush 2 ft. high, the stem branched, subterete, swollen at the nodes, the internodes 5–10 mm. long, thinly pubescent in two lines below the leaves, otherwise minutely roughened; petioles slender, 2–3 mm. long, minutely roughened; blades firm, narrowly linear, 5–9 cm. long, 4–7 mm. wide, acute at base, slightly revolute, the margin minutely denticulate, especially near the summit, 3-nerved, the lateral pair submarginal, glabrous above or minutely pubescent along the depressed midvein, very sparsely and minutely strigose along the veins beneath, the surface glabrous; secondaries obsolete above, prominent beneath, spreading at right angles; tertiaries obscure; panicle terminal, 5 cm. long, few-flowered, its axes thinly pubescent on the internodes and sparsely long-hirsute, its nodes densely pubescent and bearing oblanceolate bracts 3 mm. long; flowers 4-merous, sessile, subtended by similar but shorter bracts; mature hypanthium nearly glabrous, urceolate-campanulate; sepals broadly triangular to a short subulate tip, the exterior teeth conic-subulate, exceeding the sepals.

Brook at Central Camp, where it is covered by floods, 4800 ft., *528*. Unfortunately the plant exhibits no flowers but its habit is so strongly suggestive of *L. nervosa* that it has been placed next to that species, although abundantly different in the characters mentioned in the diagnosis.

Miconia aguitensis Gleason, sp. nov. Ramis juvenilibus profunde 4-sulcatis densissime adpresseque tomentosis pilis ferrugineis stellatis; foliis breviter petiolatis lanceolato-ellipticis acutis integris basi cuneatis insigniter 5-pli-nerviis supra sparsissime stellato-pulverulentis subtus indumento pallide brunneo stellato-lepidoto densissime obtectis; panicula mediocre pauciflora, cum ramis oppositis, pedicellis brevibus, hypanthio, et calyce stellato-tomentosula; floribus 5-meris; hypanthio subcylindrico; calycis tubo vix lobato; filamentis complanatis densiuscule stipitato-glandulosis; antheris subulatis, connectivo basi producto incrassato ventraliter dense glanduloso; ovario dense puberulo apice minute glanduloso; stylo dense glanduloso; stigmate capitellato.

Stems woody, the younger portion deeply 4-sulcate, densely covered with a fine close indument of short stellate tomentum; petioles stout, 10–15 mm. long, irregularly sulcate, tomentose like the stem; leaf-blades lanceolate-elliptic, firm in texture, as much as 19 cm. long by 6.5 cm. wide, tapering from near the middle to an acute tip, entire, cuneate to a somewhat inequilateral base, strongly 5-pli-nerved, the primaries often more or less alternate, the secondaries ascending at an angle of 70°, prominent beneath, the veinlets obscurely reticulate; upper surface sparsely and minutely stellate-pulverulent; lower surface completely covered with a close sublepidote stellate tomentum; panicle 7–10 cm. long, few-flowered, with opposite branches closely sub-

lepidote-tomentose; flowers 5-merous, on pedicels 1–2 mm. long; hypanthium subcylindric, 5.5 mm. long to the end of the calyx, finely sublepidote-tomentose; calyx-tube considerably prolonged beyond the torus, its lobes scarcely differentiated, separated by shallow notches, somewhat thickened at the middle of the margin; petals oblong, about 5.5 mm. long; stamens (not fully expanded) isomorphic but probably somewhat different in size, the anthers now 5 or 5.7 mm. long, subulate; filaments flattened, densely pilosulose with ascending glandular hairs 0.1 mm. long and set about the same distance apart, sparser apically; connective prolonged about 0.5 mm. below the pollen-sacs into a rounded organ thickened ventrally, where it bears about 20 stout glandular hairs 0.2–0.3 mm. long; ovary mostly free, its ovoid summit densely but minutely glandular on the upper third; style stout, about 7 mm. long, densely glandular like the filaments; stigma capitellate.

Agüita, 3100 ft., *933*. Cogniaux has provided for the species of this genus with glandular connectives in his section *Adenodesma*, all of which have sessile leaves. This arrangement is artificial, since certain members of the section *Tamonea* Cogn. also have glandular connectives, a fact not mentioned by him. *M. aguitensis*, because of its petioled leaves and general habit, probably belongs in the latter section, but its nearer affinities to other species of that group are problematical.

Miconia aristata Gleason, sp. nov. Fruticosa; caule terete dense tomentoso pilis stellatis stipitatibus; petiolis crassis brevibus stipitato-stellatis; laminis membranaceis anguste oblongis acuminatis 5-nerviis supra glabris inter venas primarias bullatis, subtus ad venas venulasque stipitato-stellatis, inter venas sparse stellatis; inflorescentiae ramis paucis elongatis spicatis stipitato-stellatis; floribus sessilibus 5-meris ad nodos fasciculatis; hypanthio tubuloso-campanulato stellato; sepalis ovatis quam dentibus exterioribus paullo brevioribus; petalis oblongo-cuneatis rotundatis dorso sub apicem arista parva ornatis; filamentis superne incrassatis; antheris linearibus connectivo basi non appendiculato; ovario 4-loculare; stigmate truncato.

Shrubby, the terte stems very densely brown-tomentose with stalked stellate hairs, as are also the petioles, the principal veins on the lower leaf-surface, and the inflorescence; petioles stout, 9–15 mm. long; blades thin, narrowly oblong, as much as 16 by 3.8 cm., long-acuminate, very obscurely and remotely spinulose-ciliate and occasionally obversely crenate, acute at base, 5-nerved, the outer pair submarginal, glabrous above and bullate in four longitudinal rows, sparsely stellate on the surface beneath; inflorescence terminal, short-peduncled, with a few (about 4) long branches 14 cm. long; flowers 5-merous, sessile in fascicles of 3–6 at each node; hypanthium tubular-campanulate, 2.2 mm. long to the torus, obscurely 10-angled, sparsely stellate; calyx-tube prolonged 0.3 mm.; sepals broadly ovate-triangular, 0.9 mm. long above the acute sinuses, 1.1 mm. wide, the exterior teeth triangular,

exceeding the sepals by 0.2 mm.; torus with 10 depressed-oblong, contiguous, horizontally inflexed scales; petals cuneate-oblong, rounded above, 2.2 mm. long, bearing a short erect bristle on the back just below the apex; stamens isomorphic; filaments 2.4 mm. long, gradually dilated distally to a width of 0.5 mm.; anthers linear, 2.8 mm. long, opening by a small terminal pore, the connective neither appendaged nor prolonged at base but with a small dorsal protuberance; ovary nearly free, truncate-conic, 3-celled, the sterile beak 10-sulcate; style terete, glabrous, 4.8 mm. long; stigma truncate.

Agüita, 3100 ft., *897*. It shows its relationship to *M. rhytidophylla* Naud. in its general habit and the structure of its stamens, but differs in its longer narrower leaves, glabrous and bullate above and more thinly pubescent beneath, and in the stipitate stellate hairs of the inflorescence.

MICONIA PHAEOPHYLLA Triana. A bush 4 ft. high, ridge top in the Savanna Hills, 5100 ft., *724*. The only previously known locality is Tarapoto, Peru, where it was originally collected by Spruce.

MICONIA RORAIMENSIS Ule. At Agüita, 3100 ft., *932;* a bush 8 feet tall at Desfiladero, 6000 ft., *708*. The species has been known hitherto only from the upper slopes of Mount Roraima.

Miconia silicicola Gleason, sp. nov. Arborescens; ramis crassis, obtuse quadrangularis dense stellato-tomentosis; foliis magnis sessilibus spathulato-obovatis apice acutiusculis basi abrupte contractis cordatis, supra glabris nitentibus subtus ubique densissime stellato-tomentosis; inflorescentia anguste paniculata multiflora; floribus 5-meris sessilibus; hypanthio globoso-urceolato tomentosulo apice contracto; calycis lobis late triangularibus.

A small tree; branches stout, obtusely 4-angled, densely stellate-tomentose; leaves sessile, spatulate-obovate, as much as 22 cm. long by 12 cm. wide, abruptly narrowed to an acute tip, entire, abruptly contracted below to an oblong basal portion clasping the stem by rounded auricles, 3-pli-nerved about 5 cm. above the base, with an additional submarginal pair from the base, secondaries mostly 5–7 mm. apart, with the primaries lightly impressed above and prominent beneath, the tertiaries concealed; upper surface dark green, glabrous, and shining; lower surface closely tomentose throughout with brown stellate hairs; inflorescence narrow, paniculate, its branches strongly angled and tomentose like the stem; flowers 5-merous, sessile or nearly so; fruiting hypanthium globose-urceolate, closely tomentulose, 6–7 mm. long including the persistent calyx; sepals broadly triangular, about 1 mm. long.

Woods in Laterite Valley, Savanna Hills, 4400 ft., *791;* also on the riverside at Arabupu, Mount Roraima, 4200 feet, *Tate 212* (type). Although flowers are lacking, the species is clearly a member of the section *Adenodesma*, Naud., agreeing with *M. amplexans* Cogn. in its auriculate leaves, but more closely related to *M. Plukenetii* Naud., if its general

aspect and indument may be relied upon as evidence. It differs from this latter species in its clasping, proportionately broader and blunter leaves, shining above, and tomentose beneath over the veins and surface alike.

Miconia subtriloba Gleason, sp. nov. Fruticosa; ramis superne teretibus sparsissime stellato-pulverulentis, internodis elongatis; foliis membranaceis petiolatis oblong-ovatis acuminatis, margine integris obscure ciliatis, basi longe cuneatis, utrinque sparsissime minutissime stellatis, 5-pli-nerviis; inflorescentia parva paniculata stellata; hypanthio parvo cylindrico; calycis lobis brevibus triangularibus, dentibus exterioribus parvis subulatis; petalis 4 obovatis; filamentis brevibus; antheris subulatis, majorum connectivo basi subtriloba, minorum simplice; ovario 3-loculare; stigmate truncato.

A shrub; upper branches terete, slender, very minutely and obscurely stellate-pulverulent, the internodes 6–10 cm. long; petioles slender, 2–3 cm. long, stellate like the stem; leaf-blades membranous, deep green, oblong-ovate, as much as 16 by 7.5 cm., acuminate, entire, obscurely and remotely ciliate, long-cuneate at base, 5-pli-nerved, the upper pair arising 1–2 cm. above the base, the secondaries widely spreading, prominulous, 8–10 mm. apart, the obscure tertiaries coarsely reticulate; both surfaces essentially glabrous, under the lens very sparsely and minutely stellate, especially along the primaries above; inflorescence paniculate, terminating the stem and its upper branches, 5–8 cm. long, stellate like the stem; flowers 4-merous, sessile; hypanthium short-cylindric, 2 mm. long to the torus, prominently angled, minutely stellate; calyx-tube prolonged 0.3 mm.; sepals erect, triangular, membranous, 0.6 mm. long, acute, the external teeth 0.3–0.4 mm. high, subulate-conic, scarcely projecting; petals obovate, 1.9 mm. long, 1.3 mm. wide, cuneate to a truncate base; filaments slender, 1.2–1.4 mm. long; anthers stoutly subulate, 2.5 mm. long; connective prolonged 0.6 mm. below the base of the pollen sacs and attached to the filament about the center of its ventral side, those of the epipetalous stamens narrow and somewhat flattened, those of the episepalous stamens wider, the sides somewhat ventrally bent and with an obscure lobe on each side; ovary half-inferior, 3-celled, its free summit conic and prominently furrowed; style straight, terete, 4 mm. long, the stigma truncate.

Agüita, 4000 ft., *912*. It is a member of the section *Eumiconia* Naud., and in the structure of its anthers, the venation of its leaves, and some features of its general habit resembles *M. ceramicarpa* (DC.) Cogn. and *M. nervosa* (Sm.) Triana, both common species of the lowlands. These plants have much more pubescent stem and foliage, larger 5-merous flowers, and completely isomorphic stamens.

Tococa obovata Gleason, sp. nov. Fruticosa; ramis superne copiose glanduloso-stellatis et sparse hirsutis; foliis subsessilibus late rotundato-obovatis apice ad apiculam obtusam rotundatis, insigniter ciliatis, basi ro-

tundatis vel subcordatis 5-nerviis, supra pilosis subtus praecipue ad venas venulasque minutissime stellato-pulverulentis; inflorescentia terminale parva breviter pedunculata, bracteis 2 profunde fimbriato-ciliatis suffulta; floribus 1–3, 5-meris, pedicellis longis infra basin hypanthii articulatis; hypanthio obconico glanduloso-hirsuto; calycis lobis triangularibus acutis vel subacuminatis, dentibus exterioribus subulatis; petalis obovato-oblongis; antheris insigniter complanatis, connectivo supra basin excavato; ovario semilibero 3-loculare; stylo glabro; stigmate truncato.

Shrubby, the stem above freely stellate with stout erect crooked hairs 0.1–0.2 mm. long, bearing at the apex several minute glandular branches, also (on one specimen only) sparsely hirsute with simple hairs 1.5–2 mm. long, the principal internodes 3–5 cm. long; petioles about 1 mm. long, pubescent like the stem; leaf-blades firm, opaque, obovate-elliptic to obovate-rotund, as much as 5.4 cm. long by 3.8 cm. wide, broadly rotund and subapiculate to obtuse above, lightly cordate at the rounded base, entire, prominently ciliate, 5-nerved with an obscure additional marginal pair, the secondaries 2–3 mm. apart, ascending at about 60°, the tertiaries reticulate, and all lightly impressed above and prominent beneath; upper surface sparsely pilose with curved-ascending hairs 2–3 mm. long; lower surface minutely stellate-pulverulent, especially on the veins and veinlets; inflorescence terminal, 1–2 cm. long, 1–3-flowered, the axis stellate like the stem, bearing near the middle a pair of narrowly obovate, strongly fimbriate-ciliate bracts; pedicels about 8 mm. long, articulated near the base of the 5-merous flower; hypanthium obconic, 6 mm. long, hirsute with spreading glandular hairs 1.5–2.5 mm. long over an indument of minute glandular hairs 0.1 mm. long, the staminal torus prominently thickened or fleshy; calyx-tube prolonged 0.8–0.9 mm.; sepals triangular, 2.4 mm. long from the torus, acute or subacuminate, minutely but densely glandular on the inner surface and setose at the tip; exterior teeth almost wholly adnate to the sepals and projecting in a subulate tip 2–2.4 mm. long, pubescent throughout like the hypanthium; petals light red, obovate-oblong, 15 mm. long, 9 mm. wide; stamens isomorphic; filaments about 7 mm. long; anthers straight, about 5.5 mm. long, strongly laterally flattened, opening by a ventro-terminal pore; connective strongly thickened below, conspicuously excavate on the back just above the insertion of the filament; ovary glabrous, 3-celled; style straight, terete, glabrous, 11 mm. long, the stigma truncate.

At Central Camp, 4800 ft., *593*. The species is obviously related to the next, under which some observations are made on the possible relationships of both.

Tococa montana Gleason, sp. nov. *T. obovatae* affinis, sed recedit foliis paullo angustioribus utrinque hirsutis, caule simpliciter stellata non glanduloso, hypanthio longissime hirsuto, sepalis longioribus.

Closely resembling the preceding in general habit; stem closely tomentu-

lose with minute non-glandular branched hairs and when young also freely hirsute; leaves nearly sessile, broadly elliptic, subacute, subcordate at base, densely ciliate, as much as 5.5 by 3.5 cm., 5-nerved; upper surface freely hirsute with pale brown hairs 6 mm. long; the veins beneath hirsute with curved hairs 3 mm. long and also sparsely and finely stellate; inflorescence 1–2 cm. long, 3-flowered, hirsute and minutely stellate; hypanthium obconic, 6 mm. long, densely hirsute with simple hairs 4 mm. long overlying a thin stellate indument; sepals triangular, about 4 mm. long, the exterior teeth not projecting.

Ridge northwest of Vegas Brook, 4400 ft., *1009*.

The close relationship between these two species is at once apparent, while the differences in the pubescence and shape of the sepals warrant their separation as distinct species. *T. montana* bears but a single flower, exhibiting the characteristic anthers of the genus, but it was not dissected. Neither species bears formicaria. In this they are similar to the species of the section *Anaphysca* Benth., but they are quite different from them in other features. *T. ciliata* Triana has sessile leaves of similar shape and is likewise stellate and hirsute, but has 5-pli-nerved leaves and a 5-celled ovary. Our two species are probably best regarded as an isolated group, evolved from unknown lowland ancestors, in which the reduced inflorescence, the heavy indument, and the rounded leaves show the influence of a montane environment.

Tococa oligantha Gleason, sp. nov. Fruticosa ramosa, caulibus minutissime puberulentibus et hinc inde sparsissime hirsutis; petiolis brevissimis, formicariis nullis; laminis ovatis acutis basi rotundatis ciliatis 5-nerviis, supra juventute breviter pilosis mox glabrescentibus nitentibus, subtus ad venas sparse breviterque pilosis ceterum glabris; inflorescentia (in typo) biflora, floribus terminalibus sessilibus; hypanthio obconico minutissime puberulente; calycis limbo patente truncato; petalis parvis roseis.

A branching shrub; internodes roundly 4-angled or terete with age, 3–5 cm. long, minutely puberulent and sparsely short-hirsute; petioles 2 mm. long, freely short-hirsute; blades ovate, rather thin, shining above, 4.5–5.2 cm. long, 2.3–3 mm. wide, sharply acute, ciliate, broadly rounded at base, 5-nerved, very sparsely pilose above with short hairs 0.8 mm. long, sparsely and minutely puberulent beneath throughout and very sparsely short-pilose on the primaries; veins nearly plane above, lightly elevated beneath, the secondaries 2–3 mm. apart, spreading at an angle of 70°; inflorescence terminal on a peduncle 25 mm. long, pubescent like the stem; flowers 2, sessile; hypanthium obconic, 4.5 mm. long, minutely puberulent; calyx-limb somewhat spreading, truncate, 1.5 mm. wide; petals rose, about 5 mm. long.

Moist slopes of Savanna Hills, 4400 ft., *774*. The species resembles the two preceding in general habit, but differs from them in the nearly

glabrous leaves and hypanthium and the completely truncate calyx, and apparently has no close relative with which it may be compared. Another specimen with numerous fruiting hypanthia crowded in a dense panicle, *761*, from Laterite Valley, Savanna Hills, 4400 ft., has been referred here tentatively. Agreeing with the type in general habit, pubescence, and truncate calyx, its leaves approach a broadly elliptic outline, are blunter at the tip, and often subcordate at base.

Clidemia duidae Gleason, sp. nov. Fruticosa; ramis dense ferrugineo-tomentosis; foliis longe petiolatis subcoriaceis late ovatis apice subacutis minute spinuloso-ciliatis basi late cordatis 7-nerviis, supra ad venas primarias tomentosulis ceterum glabris, subtus ad venas dense tomentosis, ad venulas sparse stellato-puberulis ceterum glabris; inflorescentia ampla paniculata terminale vel subterminale dense stellato-tomentosa et copiose glanduloso-pilosa; floribus 4-meris breviter pedicellatis; hypanthio subcylindrico tomentoso et glanduloso-piloso; sepalis brevibus late ovatis rotundatis vel subacutis, dentibus exterioribus duplo longioribus; toro squamas 10 fimbriatas introrsas gerente; filamentis crassis complanatis; antheris subulatis, connectivo non producto; ovario semilibero apice rostrato 3-loculare.

Stems woody, the upper portions densely tomentose with reddish brown, plumose or stellate hairs; petioles stout, 2–4 cm. long, tomentose like the stem; leaf-blades subcoriaceous, broadly ovate, as much as 10.5 cm. long by 8 cm. wide, rounded to a subacute tip, minutely and remotely ciliate with appressed spinulose teeth, cordate at base, 7-nerved, the primaries and secondaries lightly impressed above, prominent beneath and with the tertiaries conspicuously reticulate, the secondaries 2–3 mm. apart, spreading at nearly right angles; upper surface glabrous, the primaries thinly stellate-tomentose when young, becoming almost glabrous at maturity; lower surface glabrous, the tertiaries barely pulverulent, the secondaries sparsely and the primaries densely stellate-tomentose with red-brown hairs; inflorescence ample, terminal or subterminal, paniculate, 10–20 cm. long, thinly stellate-tomentose and copiously glandular-pilose; flowers 4-merous, on glandular and tomentose pedicels 2–3 mm. long; hypanthium subcylindric, 4.4 mm. long to the torus, thinly stellate with minute red stellate hairs and sparsely glandular with spreading hairs 0.6–0.8 mm. long; calyx-tube prolonged 0.5 mm.; sepals somewhat fleshy, broadly depressed ovate or subtriangular, 0.8 mm. long, the free margin very narrow; exterior teeth stout, triangular, acute, ascending, projecting about 0.8 mm.; staminal torus bearing 10 purple scales, as much as 0.9 mm. long, prominently glandular tomentose, projecting across the throat of the hypanthium; petals oblong, 4 mm. long; stamens isomorphic, the stout flattened filaments and the subulate anthers each 4 mm. long, the connective neither prolonged nor appendaged; ovary terminating in a conspicuous rostrum, 3-celled; style 6.5 mm. long; stigma truncate.

Summit of Peak 7, 7050 ft., *666*. Cogniaux, in his monograph of the family *Melastomataceae*, places all species with paniculate 4-merous flowers in the section *Sagraea* Cogn. Our species, although presenting these characters, seems to be related rather to such well-known lowland species as *C. hirta* (L.) D. Don and *C. dentata* D. Don, as shown by its general habit and especially by the prominent scales on the staminal torus. It differs from these and the other known species of similar structure in its 4-merous flowers, stellate pubescence, and the introrse direction of the toral scales.

CLIDEMIA MINUTIFLORA (Triana) Cogn. A tree at Agüita, 4000 ft., *909;* hitherto known from the lowlands of the upper Amazon valley and British Guiana.

Clidemia piperifolia Gleason, sp. nov. Ramis densissime strigosis; foliis in eodem jugo valde inaequalibus, petiolatis, ovatis, subintegris, basi late inaequaliter rotundatis, alternatim 7-pli-nerviis, supra papillis depressis juventute setiferis dense obtectis et ad venas pilosis, subtus dense pilosis; floribus axillaribus sessilibus 4-meris; hypanthio fructifero carnoso coeruleo dense strigoso; calycis margine integro, dentibus exterioribus 8 subulatis; ovario semilibero apice breviter setoso.

Stems woody, very densely strigose or subtomentose with stout brown hairs about 1 mm. long, the principal internodes 3–6 cm. long; petioles stout, pubescent like the stem, 3–15 mm. long; leaves firm in texture, ovate, those of each pair strongly dissimilar in size, acuminate, nearly entire, rounded or broadly obtuse to an inequilateral base, conspicuously and alternately 7-pli-nerved; upper surface covered with contiguous angular depressed papillae, tipped with a minute seta and hence scabrous when young, becoming smooth with age, the primaries, especially the midvein, villous; lower surface finely reticulate, the primaries villous, the secondaries and veinlets closely hirsutulous, the actual surface glabrous; flowers 4-merous, sessile in fascicles of 2–6 in the axils; fruiting hypanthium stoutly ovoid, fleshy, blue, 6 mm. long, densely strigose or subhirsute with slender hairs 1–1.5 mm. long; calyx-tube prolonged 0.5 mm., thin or subscarious, entire, the sepals obsolete; external teeth 8, erect, subulate, pubescent like the hypanthium, alternately 1 and 2 mm. long; summit of the ovary minutely setose.

A bush on Agüita Slope, about 4000 ft., *866*. This remarkable *Clidemia*, which unfortunately lacks flowers in blooming condition, is distinguished by three peculiar features. The leaves are distinctly anisophyllous, the larger as much as 16 by 10 cm., and the smaller half as large or even less; in the larger one side of the blade extends 2–3 mm. farther down the petiole than the other side. The large leaves are alternately pli-nerved, while the small ones are oppositely pli-nerved. In the largest leaf present the lowest

vein arises 3 mm. from the base of the leaf; the second is 4 mm. from the base on its side and 6 mm. above the first; the others arise at distances of 6, 8, 18, and 14 mm. apart. The third feature is the double row of exterior teeth. The large ones are probably the true teeth and the small ones accessory, but this can not be verified in the absence of the petals.

Topobea ferruginea Gleason, sp. nov. Arbor; foliis subcoriaceis, internodis brevibus confertis, foliis oblongo-ellipticis ad apiculam obtusam abrupte acuminatis integris basi acutis 5-pli-nerviis, supra glabris nitidis, subtus densissime ferrugineo-tomentosulis; floribus 1 vel paucis in axillis superioribus pedicellatis; bracteis 4 in jugibus 2 connatis hypanthio fructifero multo brevioribus; calycis tubo irregulariter truncato.

A tree 25 feet high, the upper branches irregularly angled and minutely furfuraceous, soon becoming subterete and glabrous, the internodes about 1 cm. long; petioles stout, 2–3 cm. long, thinly furfuraceous; leaf-blades subcoriaceous, oblong-elliptic, as much as 14 cm. long by 7 cm. wide, abruptly acuminate to an obtuse tip, entire, acute or subcuneate at base, 5-pli-nerved, the outer pair submarginal, the secondaries obscure, 1–2 mm. apart; upper surface glabrous, dark green and shining; lower surface densely but thinly ferruginous-tomentulose; fascicles few-flowered, in the upper axils, on tomentulose pedicels 15–20 mm. long; bracts 4, connate in 2 pairs, broadly rotund, ferruginous-tomentulose, the outer 7, the inner 10 mm. long; fruiting hypanthium campanulate, 13 mm. long, including the irregularly truncate calyx-tube.

In Camp Woods, Savanna Hills, 4400 ft., *850*. Since the specimen lacks flowers, its position in the genus *Topobea* is open to question and later collections may show that it is a *Blakea* instead.

Two specimens of this family are completely sterile and can not be identified with a genus; *698*, a vine creeping up moist rocks, resembling an *Adelobotrys*, and *818*, a bush with small strongly 5-pli-nerved leaves. Number *806*, with linear-lanceolate coriaceous leaves, may be a *Tococa*.

ARALIACEAE

Species of Mount Duida

Didymopanax montanum Gleason, sp. nov. Fruticosum, ramis superne crassis multistriatis, internodis brevissimis; foliis simplicibus, petiolis crassis brevibus, laminis oblanceolatis apice ad apiculam minutam rotundatis infra medium ad basin obtusam angustatis paullum revolutis supra glabris nitentibus subtus cinereis dense adpresseque tomentosis; pedunculis compluribus in axillis superioribus confertis; pedicellis non articulatis; hypanthio ellipsoideo sericeo; calyce breve, lobis triangularibus acutis e sinubus latis; petalis triangulari-ovatis 1-nerviis apice incrassatis et minute deflexis; antheris triangularibus introrsis quam filamentis multo longioribus; stylis 2 supra medium

connatis superne recurvatis vel patulis; ovario 2-loculare; baccis immaturis orbicularibus.

A shrub 10 ft. high, the leafy twigs stout, many-striate (at least when dry), the internodes about 5 mm. long; leaves simple; petioles stout, 8–12 mm. long; blades firm, oblanceolate, 10–15 cm. long, 3–4 cm. wide, rounded above to an apiculum 1–2 mm. long, slightly revolute, narrowed from above the middle to an obtuse base, glabrous and very shining above, with elevated midvein, densely but very thinly covered beneath with a cinereous tomentum; lateral veins obscure, ascending at an angle of 60°; inflorescence of several compound umbels closely crowded in the uppermost axils, thinly and closely cinereous, bracts and bractlets minute, triangular-ovate, the peduncle 4 cm. long, its branches 8–12 mm. long, some of them again branched with pedicels 4–6 mm. long and not articulated; hypanthium ellipsoid-flattened, obscurely 10-ribbed, minutely sericeous, 3.2 mm. long; calyx-limb somewhat spreading, its 5 lobes triangular, acute, 0.7 mm. long and wide, separated by broad flat sinuses; petals fleshy, triangular-ovate, 2 mm. long, acute, glabrous, 1-nerved on the inner face, thickened and abruptly deflexed at the summit; anthers triangular, acute, 1.3 mm. long, dorsifixed, about twice as long as the stout filaments; ovary 2-celled; styles 2, stout, 1.5 mm. long, connate for about two-thirds their length, spreading or recurved above; fruit (perhaps immature) flat, orbicular, 8 mm. in diameter.

Slopes of Ridge 25, 5500–6000 ft., *458*. Simple-leaved plants are the exception in the genus, and I know of no other which unites this character with the connate styles.

Didymopanax reticulatum Gleason, sp. nov. Caulibus superne crassis cicatricibus foliorum delapsorum dense obtectis; petiolis elongatis basi late expansis, supra insertionem in stipulas semiovatas margine cartilagineas productis; foliolis 5 petiolulatis oblongis acutis basi rotundatis vel oblique truncatis subtus reticulatis; paniculis compluribus elongatis umbellas pedicellatas racemose gerentibus; floribus sessilibus; petalis valvatis; sepalibus ad dentes minutos reductis; ovario 2-loculare; stylis crassis ad medium connatis.

Stems above very stout and thick, with very short internodes, the large, nearly semicircular leaf-scars almost contiguous; leaves crowded at the summit of the stem; petioles stout, elongate, 10–12 cm. long, greatly expanded at base, the thin sides free at the summit and prolonged into semi-ovate stipules 10–15 mm. long, with cartilaginous margins; blades about 5, on stout petiolules 2–3 cm. long, subcoriaceous, oblong, 8–14 cm. long, 3–6 cm. wide, abruptly acute, rounded or obliquely truncate at base, glabrous, the veins rather obscure and nearly plane above, prominent and conspicuously reticulate beneath; panicles several, terminal, the stout, straight, strongly angled rachis about 10 cm. long, bearing numerous lateral umbels on stalks 10–15 mm. long; flowers sessile; sepals reduced to minute teeth;

petals triangular-ovate, valvate; stamens not seen; ovary 2-celled; styles 2, connate to about the middle, thence recurved-spreading; fruit flattened.

Summit of Peak 7, 7100 ft., *606*. The species is apparently related to *D. rubiginosum* (Planch. & Lind.) March., of Colombia. Another specimen from Agüita, 3100 ft., *940*, has also been referred here, notwithstanding some notable differences in dimensions. The petiole is 45 cm. long, the petiolules 10 cm., and the panicles 25 cm.; the leaves are less conspicuously reticulate beneath.

DIDYMOPANAX RUGOSUM N. E. Brown. Summit of Peak 7, 7100 ft., *607*. The species has been considered endemic to Mount Roraima.

DIDYMOPANAX SPRUCEANUM Seem. A small tree at Agüita, 3100 ft., *876*. Our plant is sterile and is referred to this species with some hesitation. It agrees essentially in foliar characters with Spruce's original collections from San Gabriel and the Rio Uaupes.

SCHEFFLERA UMBELLATA (N. E. Brown) Viguier. Slopes of Ridge 25, 5500–6000 ft., *431*, a shrub 10–12 ft. high; a bush at Desfiladero, 6100 ft., *695*. This and the nearly related *S. coriacea* (March.) Harms have been known heretofore only from Mount Roraima.

ERICACEAE[1]

Species of Mount Duida

Ledothamnus parviflorus Gleason, sp. nov. Frutex nanus; foliis petiolatis linearibus minimis glabris adscendentibus obtusis juventute puberulentibus mox glabratis; floribus solitariis terminalibus pedicellatis; pedicellis minute glanduloso-tomentosis; sepalis 5 vel 6 lanceolatis pubescentibus; corollis staminibusque omnibus delapsis; stylo breve crasso apice 3–4-lobato; capsula parva verrucosa 3–4-valvata.

A freely branched shrub 2–3 dm. high from a thick woody base, of ericoid aspect; young branches angular, thinly pubescent, soon becoming nearly terete, glabrous, and defoliated, the internodes at maturity 1.5 mm. long; petioles subappressed to the stem, almost white, 1 mm. long, glabrous on the back, pubescent on the upper side; leaves in whorls of three, ascending and imbricate, thick, stoutly linear, 3–4 mm. long, 0.8 mm. wide, obtuse, flat and nerveless above, deeply sulcate beneath, minutely pubescent when young, eventually glabrous; flowers solitary at the end of the branches, sometimes appearing clustered if the branches are short; pedicels erect, 5–6 mm. long, minutely glandular-pubescent; sepals 5 or 6, ascending, linear-lanceolate, 2 mm. long, acute and slightly inflexed, finely ciliate, persistent but not enlarged in fruit; corolla and stamens unknown; style stout, 0.8 mm. long,

[1] Partly by Albert C. Smith.

enlarged distally and shallowly 3–4-lobed; capsule ovoid, strongly verrucose, 3–3.5 mm. long, septicidal, 3–4-celled.

Gorge of Caño Negro, Savanna Hills, 4000 ft., *815*. The collector notes that the flowers are white, 5–6-parted, with 5 or 6 stamens. The genus *Ledothamnus* is apparently endemic to the mountain system of which Duida and Roraima form a part, with two species on Roraima and the third on Duida. The Roraima species have a 5–8-valved capsule and a 5–8-lobed stigma, with much larger flowers, the sepals being 6–9 mm. long; the flowers are red, so far as known. Our species most closely resembles *L. guyanensis* Meissn., having flowers on glandular pedicels.

Bejaria variabilis A. C. Smith, sp. nov. Frutex; ramis ramulisque glabris vel hispidis; foliis ovato-oblongis, apice obtusis, basi subcuneatis, margine integerrimis, revolutis, supra hispidis vel glabris, subtus glaucis et glabris; inflorescentia laxe racemosa, rachide pedicellisque hispidis (vel glabris); calyce campanulato, lobis ovatis, leviter imbricatis; petalis obovatis, staminibus petalis aequilongis, filamentis puberulis; stylo filiforme.

Shrub; branches cinereous, subglabrous; branchlets densely and persistently hispid, the hairs spreading, 0.6–1.2 mm. long, gland-tipped (glands probably deciduous with age); leaves coriaceous, ovate-oblong, 20–30 mm. long, 10–14 mm. broad, rounded or subcuneate to the narrowly winged petiole (petiole 1–2 mm. long), obtuse at apex, entire and slightly revolute at margins, shining and glandular-hispid (especially near margins) above when young, becoming glabrous, glaucous and glabrous beneath, rarely hispid on midvein, venation pinnate, the midvein slightly depressed above, prominent beneath, the secondary veins spreading, obscure; inflorescence laxly racemose, racemes terminal or axial, 8–20-flowered, rachis 2–4 cm. long, subterete, glandular-hispid at the branchlets and minutely pale-puberulent; pedicels slender (0.5 mm. in diameter), glandular-hispid (hairs 0.3 mm. long) and sparsely puberulent, 12–20 mm. long, subtended at base by a subcoriaceous linear-oblong bractlet 3–7 mm. long, deciduously bibracteolate slightly below the middle with subspatulate bractlets about 2 mm. long, slightly swollen towards apex, subarticulate with calyx; calyx campanulate, glabrous, about 4 mm. in diameter and 3.5 mm. long including lobes, the lobes 5, ovate, 1–1.5 mm. long, about 2 mm. broad, obtuse, slightly imbricate at margins; petals 5, glabrous, membranaceous, obovate, about 22 mm. long and 8 mm. broad, attenuate at base, rounded at apex; stamens 10, as long as the petals, filaments linear, about 0.5 mm. broad, deciduously minutely puberulent, anthers attached at the middle dorsally, about 2 mm. long, 1.2 mm. broad, dehiscing by oblique terminal pores; ovary glabrous, depressed-spherical, 5-celled, ovules many; style glabrous, filiform, up to 3 cm. long, 0.5 mm. in diameter; stigma subhemispherical, 1 mm. in diameter.

Ridge top, Savanna Hills, 5100 ft., *723*. It is a species related to *B. guianensis* Kl., from which it differs by having the leaf-base rounded-cuneate rather than cuneate-attenuate, the leaves glabrous (at least at maturity) rather than persistently glandular-hispid on both surfaces, and the calyx glabrous rather than hispid. The plant in the center of the herbarium sheet is here mentioned as typical. The plant on the right has its young branches glabrescent, its rachis and pedicels not hispid, its leaves completely glabrous, and its calyx lobes puberulent at margins. This species, like most others of *Bejaria*, is very variable in the pubescence of its branchlets, racemes, and pedicels. In the past too much emphasis has doubtless been placed upon pubescence as a specific character, and a revision of this difficult genus will be feasible only in connection with intensive field study.

VACCINIACEAE[1]

Species of Mount Duida

Gaylussacia cacuminis A. C. Smith, sp. nov. Fruticosa ramosa, ramis pubescentibus internodis brevibus; foliis coriaceis sessilibus elliptico-oblongis utrinque acutis subrevolutis supra ad venam mediam pubescentibus ceterum glabris, subtus molliter pubescentibus praecipue ad venas; venis supra impressis reticulatis; racemis nutantibus 3—7-floris pilis simplicibus et glandulosis dense pubescentibus, bracteis foliaceis ovalibus obtusis, bracteolis lanceolatis acuminatis, pedicellis gracilibus bracteas paullum excedentibus; calycis glandulosi et pubescentis lobis triangularibus acutis.

Stems branching, freely and softly pubescent, the internodes about 8 mm. long; leaves crowded, sessile, coriaceous, elliptic-oblong, 20–30 mm. long, 8–10 mm. wide, acute at both ends, glandular-apiculate, somewhat revolute, thinly pubescent on the midvein above, otherwise nearly or quite glabrous, softly pubescent beneath, especially on the veins; veins deeply impressed and reticulate above; racemes from the upper axils, nodding, 3–4 cm. long, 3–7-flowered, densely pubescent with slender simple hairs 0.4 mm. long and stouter erect glandular hairs 1–1.3 mm. long; bracts ovate to broadly oblong or obovate, sessile, 6–7 mm. long, 3–4 mm. wide, softly pubescent on both sides, especially on the veins, and glandular-ciliate; bractlets 2 at base of each pedicel, lanceolate, 6–7 mm. long, long-acuminate, pubescent and glandular; pedicels 5–9 mm. long, pubescent like the raceme; calyx-tube tubular-campanulate, 3 mm. long, densely pubescent with short simple hairs and sparsely glandular with much longer hairs, its lobes triangular, acute, 1.6 mm. wide, 2.4 mm. long, pubescent like the tube; style compressed, 5 mm. long, stigma peltate.

[1] By Albert C. Smith.

Summit of Peak 7, 7100 ft., *616*. The foliage and general habit of the plant suggest at once its affinity with *G. buxifolia* HBK., of Colombia. The Andean plant has veins less impressed and the terminal apiculum much shorter, lacks glands on the rachis of the raceme, and has bracts long-cuneate at base, acute at apex, and longer than the pedicels, as well as other minor differences.

THIBAUDIA FORMOSA Kl. Dry slope on Savanna Hills, 4400 ft., *729;* Agüita, 4000 ft., *903*. The species has previously been known only from a single collection from Mount Roraima.

Thibaudia glandulifera A. C. Smith, sp. nov. Frutex ramosus; laminis ovatis apice subacutis basi rotundatis vel cuneatis margine integerrimis vel subserratis pinnatinerviis; inflorescentia fasciculata pauciflora; pedicellis calycibusque cum pilis brevibus atque etiam cum pilis longis glandulosis pilosis; calyce campanulato; corolla cylindrica glabra; staminibus aequalibus, filamentis subglabris basi laxe connatis, tubulis quam loculis triplo longioribus.

Straggling shrub about 1 meter high; branchlets grayish, glabrous or sparsely pubescent with deciduously glandular hairs 1–1.5 mm. long; leaf-blades thick-coriaceous, ovate, 2–3.5 cm. long, 12–18 mm. broad, glabrous or sparsely white punctate or sparsely pubescent on both surfaces with minute black hairs (not exceeding 0.5 mm. in length), subacute at apex, entire or bluntly serrate at margins (serrations 3–4 mm. long), rounded or cuneate at base to a thick petiole 2–3 mm. long, pinnate-veined, the midvein impressed above, raised beneath, the secondary veins about 3 to a side, arcuate, obscure or faintly raised on both surfaces, the veinlets reticulate, obscure or plane; flowers fasciculate in groups of about 5, fascicles axillary near ends of branchlets; pedicels 10–13 mm. long, slender (about 0.7 mm. in diameter), longitudinally ridged, pubescent with close minute short pale hairs (0.1 mm. long) and also with scattered erect ferruginous glandular hairs (0.9–1.5 mm. long), with a few triangular acute sessile bractlets (about 1 mm. long) near base; calyx articulate with pedicel, campanulate, pubescent with glandular hairs (as those of the pedicel), about 4 mm. long and 4 mm. in diameter at summit, with 5 short subacute lobes; corolla cylindric, somewhat fleshy, glabrous, 12–13 mm. long, 2–3 mm. in diameter at base, with 5 triangular lobes about 1 mm. long; stamens 10, equal, 9–10 mm. long; filaments 3.5–5 mm. long, sparsely pubescent at their junction with anthers with pale hairs about 1 mm. long, loosely connate at base; inferior parts of anthers granular, about 1.5 mm. long; tubules membranaceous, about 4.7 mm. long, with pores extending for nearly their entire length on interior surfaces; style filiform, about 10 mm. long, the stigma hemispherical, about 0.8 mm. in diameter; fruit subspherical, 6 mm. or more in diameter, retaining pubescence of calyx.

Summit of Ridge 25, 6300 ft., *409* (type); slopes of Ridge 25, 5500–6000 ft., *457*. The present species is well marked from the two following

by the glandular hairs of its pedicels and calyces. Description of the fruit is from no. *457*. Closely allied are two other specimens (nos. *754* and *755*, from Savanna Hills, 4400 ft.), both of which are in fruit. The leaves are larger and of a slightly different texture than those above described. Possibly they represent a slight variation of the species.

The three new species of *Thibaudia* described here are all closely related to *T. nutans* Kl., with which they form a somewhat isolated group in the genus.

Thibaudia involucrata A. C. Smith, sp. nov. Frutex ramosus; laminis late ovatis basi cuneatis apice subacutis margine integerrimis vel subserratis pinnatinerviis; inflorescentia fasciculata pauciflora; floribus minute puberulentibus; pedicellis apice a bracteolis connatis superatis; calyce campanulato 5-lobato; corolla cylindrica; staminibus aequalibux, filamentis distinctis parce pilosis, tubulis quam loculis duplo longioribus.

Low shrub; branchlets subterete, glabrous; petioles stout (about 2 mm. in diameter), about 5 mm. long, winged nearly to base; leaf-blades thick-coriaceous, broadly ovate, 3.5–7 cm. long, 2–4 cm. broad, obtuse or subacute at apex, cuneate at base, entire or shallowly serrate at margins (serrations 5–10 mm. apart), slightly revolute, sparsely black-punctate on both surfaces, pinnate-veined, the midvein impressed above, prominent beneath, the secondary veins 3–5 to a side, arcuate or spreading, plane above, raised beneath, the veinlets reticulate, obscure above, raised beneath; flowers in axillary fascicles, 3–5 to an inflorescence, each fascicle circumscribed by 3 or 4 subcoriaceous triangular obtuse faintly ciliate bracts about 1 mm. long; pedicels, involucres, calyces and corollas finely puberulent with minute pale hairs; pedicels subterete, stout (1 mm. in diameter), 3–5 mm. long, surmounted by persistent involucres of two coriaceous keeled acute fused bracts 1–2 mm. long; calyx-tube articulate with pedicel, subcylindric, about 2 mm. long, widening into a campanulate limb 1.5 mm. long and 3 mm. in diameter at summit, with 5 triangular acute lobes 1 mm. long; corolla cylindric, fleshy, 7–8 mm. long, about 2.5 mm. in diameter at base, with 5 triangular acute lobes 1 mm. long; stamens 10, of equal length (5–6 mm.); filaments about 2.5 mm. long, sparsely pubescent at their junction with the anthers with short pale hairs, loosely connate at base; inferior parts of anthers finely granular, about 1.2 mm. long; tubules membranaceous, about 3 mm. long, with clefts extending about 1 mm. down their interior surfaces; style filiform, about 8 mm. long, the stigma flattened, 0.8 mm. across; fruit spherical, 3–4 mm. in diameter, coriaceous, the calyx persistent.

Near summit of Ridge 25, 6000 ft., *525* (type); Desfiladero, 6100 ft., *694*. It is a species distinguished from *T. nutans* Kl. and the others here described by the two fused bractlets surmounting the pedicel.

Thibaudia truncata A. C. Smith, sp. nov. Frutex humilis; laminis ovatis

apice subacutis basi rotundatis pinnatinerviis; floribus axillaribus ut videtur solitariis minute puberulentibus; calyce campanulato, limbo minutissime apiculato; corolla cylindrica; staminibus aequalibus, filamentis subdistinctis, tubulis quam loculis duplo longioribus.

Low shrub; branchlets terete, glabrous; petioles about 4 mm. long, stout (1.5 mm. in diameter); leaf-blades thick-coriaceous, ovate, 3–4.5 cm. long, 2–3 cm. broad, glabrous or sparsely punctate on both surfaces, subacute at apex, entire and plane at margins, rounded at base, decurrent on petiole, pinnate-veined, the midvein impressed above, raised beneath, the secondary veins 3 or 4 to a side, spreading, obscure above, plane or slightly raised beneath, veinlets reticulate, obscure; flowers axillary, apparently solitary; pedicels, bractlets, calyces and corollas finely puberulent with minute pale hairs; pedicels longitudinally ridged, slender, 9–10 mm. long, with 2 or 3 triangular subacute sessile bractlets on the lower half; calyx articulate with pedicel, campanulate, slightly constricted at summit of tube, about 3 mm. long, 4 mm. in diameter at summit, with 5 minute apiculate teeth; corolla cylindric, somewhat fleshy, 10 mm. long, 2–3 mm. in diameter at middle, with 5 triangular obtuse lobes 1.5 mm. long; stamens 10, of equal length (about 9 mm.); filaments about 3.5 mm. long, faintly pubescent at their junction with anthers with pale short hairs, loosely connate at base; inferior parts of anthers finely granular, about 2 mm. long, the tubules membranaceous, about 4 mm. long, with pores extending nearly their entire length along the interior surfaces; style filiform, about 11 mm. long, the stigma peltate, 0.6 mm. in diameter.

Summit of Peak 7, 7100 ft., *602*. The present specimen is very incomplete, with only one intact flower, but it is obviously quite distinct from the other species of the region on the basis of its truncate calyx-limb and pale puberulous flowers.

Mycerinus A. C. Smith, gen. nov.

Calyx cum pedicello articulatus turbinatus anguste 5-alatus alis lobis oppositis limbo dilatato. Corolla carnosa cylindrica 5-lobata. Stamina 10 quam corolla breviora, filamentis distinctis, connectivis divisis, antheris robustis, tubulis distinctis brevibus rimis ovalis introrsis dehiscentibus. Frutex parvus laminis alternatis crasso-coriaceis breviter petiolatis pinnatinerviis. Inflorescentia pauciflora fasciculata vel breviter racemosa.

Calyx articulate with pedicel, turbinate, the base cuneate, the limb dilated, 5-lobed, narrowly winged, each wing continuing to the apex of a lobe; corolla cylindric, carnose, 5-lobed; stamens 10, shorter than corolla; filaments stout, glabrous, distinct, attached to the anther dorsally near middle, continued into short connectives which divide into 2 slender arms each of which continues to the apex of a tubule; anthers erect, stout, the sacs finely granular, the tubules 2, short, membranous, each dehiscing by an introrse oval cleft

more than half its length; disc shallowly cup-shaped; ovary 5-locular; style stout, the stigma truncate. A low shrub, the branches and branchlets subterete, glabrous; leaves alternate, thick-coriaceous, short-petiolate, pinnate-veined, the base rounded or subcuneate, the apex obtuse, the margin entire and strongly recurved; inflorescence few-flowered, fasciculate or short-racemose, flowers pedicellate, the pedicels deciduously bracteolate.

Named from Mycerinus, a king of Egypt about 3700 B.C. The custom of naming genera of Vacciniaceae after historical figures was established by Klotzsch.

This remarkable genus, represented by the single species below described, is characterized by having its calyx-wings opposite the lobes and its divided connective extended to the summits of the tubules. It belongs in the tribe *Thibaudieae*, and probably is most closely allied to *Macleania* Hook. However, the genus *Macleania* has the calyx-wings, when present, opposite the sinuses, and the filaments are never continued as they are in the new genus. The short conical tubules demonstrate the affinity of these two genera. The alliance of *Mycerinus* to *Thibaudia* R. & P. is more remote.

Mycerinus sclerophyllus A. C. Smith, sp. nov. Frutex parvus generis characteribus; laminis ovato-oblongis basi rotundatis vel subcuneatis apice obtusis margine valde revolutis pinnatinerviis; floribus ut supra descriptis.

Low shrub about 1 meter high; branches with a thick grayish bark; branchlets angled, glabrous; petioles thick (2–3 mm. in diameter), 2–5 mm. long, sometimes winged above; leaf-blades thick-coriaceous, ovate-oblong, 4–6 cm. long, 2–3 cm. broad (the apparent width about 1.5 cm. because of revolute margins), sparsely black-punctate on both surfaces, obtuse at apex, rounded or subcuneate at base, much thickened and loosely revolute at margins, pinnate-veined, the midvein impressed above, prominent beneath, the secondary veins 6–8 to a side, spreading nearly to margins, plane or slightly impressed above, raised beneath, the veinlets reticulate, obscure or plane; flowers fasciculate or short-racemose, 2–4 to an inflorescence, axillary near ends of branchlets; pedicels subterete, 15–20 mm. long, stout (1–1.5 mm. in diameter), glabrous, with 2 or 3 deciduous triangular sessile bractlets (about 1 mm. long) at both base and summit; calyx articulate with pedicel, coriaceous, turbinate (the tube occupying the lower two thirds), about 8 mm. long, 5–6 mm. in diameter near summit, tapering to a cuneate base, strongly winged for entire length by 5 fleshy coriaceous wings, each of which continues to the apex of a calyx-lobe, the lobes 5, incurved, triangular, acute, about 3.5 mm. across base and 2 mm. long; corolla tubular, subcylindric, very fleshy, about 6 mm. long and 5 mm. in diameter at middle (not quite mature in our specimen), with 5 triangular acute lobes; stamens 10, of equal length (about 4 mm.); filaments castaneous, very fleshy, 2 mm. long, 0.8 mm. broad, at-

tached at middle of exterior surface of anther, extending a pale slender arm up each tubule to its summit, loosely connate at base; anther-sacs finely granular, about 3 mm. long, stout (about 1.1 mm. in diameter), the tubules membranaceous, separable to a length of 1.5 mm. (the separation extending down between the anther-sacs), with wide clefts about 0.8 mm. long on their interior surfaces; style cylindric, stout (0.8 mm. in diameter), about 6 mm. long (Pl. 36).

Summit of Peak 7, 7100 ft., *603*.

Cavendishia duidae A. C. Smith, sp. nov. Frutex parvus; laminis ovato-oblongis vel ovato-lanceolatis basi subcordatis vel truncatis apice acuminatis 5-pli-nerviis; inflorescentia racemosa basi bracteis papyraceis ovatis instructa glabra; floribus glabris; calycis tubo breviter cylindrico, limbo quam tubo paullo longiore, lobis callosis; corolla cylindrica; staminibus alternatim leviter inaequalibus, filamentis subglabris, tubulis quam loculis duplo longioribus.

Shrub about 1 meter high with slender branches; branchlets terete, glabrous; petioles stout (2–3 mm. in diameter), 4–7 mm. long, glabrous or subpuberulous on the upper surface; leaf-blades coriaceous, ovate-oblong or ovate-lanceolate, 6–10 cm. long, 3–5.5 cm. broad, glabrous, rounded to a subcordate or truncate base, acuminate at apex, entire and somewhat reflexed at margins, 5-pli-nerved, the primary nerves impressed above, prominent beneath, the second and third arcuate, ascending nearly to apex, the fourth and fifth following the margins about one third their length, the veinlets reticulate, raised above, plane beneath; flowers in terminal racemes, the rachis subterete, glabrous, up to 11 cm. long when mature; bracts papyraceous, pale red, glabrous, ovate, 15–25 mm. long, 12–15 mm. broad, rounded at apex, entire and crenulate at margins, with 5–8 subparallel veins, deciduous; pedicels alternate, stout (1–1.5 mm. in diameter), subterete, glabrous, 8–12 mm. long, with 3 or 4 triangular glabrous bractlets about 2 mm. long near base; calyx-tube articulate with pedicel, cylindric, about 2 mm. long, irregularly ribbed and lobed at base; limb campanulate, 2–2.5 mm. long, 4–5 mm. in diameter at summit, with 5 triangular subacute cartilaginous lobes 1 mm. long; corolla membranaceous, cylindric, 18–22 mm. long, about 3 mm. in diameter at base, with 5 triangular lobes 1 mm. long; stamens 10, subequal, 16–17 mm. long (filaments and anthers compensatingly unequal); filaments loosely connate at base, glabrous or sparsely pilose with short pale hairs, 2 mm. and 3–4 mm. long respectively; anther sacs slightly granular, about 5.5 mm. and 4.5 mm. long respectively; tubules membranous, about 11 mm. and 9 mm. long respectively, opening by clefts more than half as long; style filiform, shorter than corolla, the stigma truncate.

Agüita Slope, 3500 ft., *703*, *1048* (type). The species is also represented by *Schomburgk 1018* at Kew, probably collected in the same general region, and by *Holt & Blake 708*, collected on Cerro Yapacana, a moun-

tain somewhat similar to Mount Duida with an elevation of about 4000 feet, lying 100 miles to the northwest. It is most closely allied to *Cavendishia amalfiensis* Mansf., from which it differs by having the inflorescence much longer, the filaments completely free, and the long filaments pilose. This is the only species of its genus thus far known from the Pacaraima Mountains.

Specimens not referred above: *582*, *Disterigma*, probably new species, but material insufficient; *635*, *Cavendishia* ?, undeterminable; *680*, *Vaccinium* sp. ? corolla lacking; *701*, probably *Sophoclesia major* Griseb., but undeterminable with accuracy; *862*, possibly *Vaccinium*, insufficient material; *1047*, *Sophoclesia*, probably new species, but material insufficient.

MYRSINACEAE[1]

Species of Mount Duida

Conomorpha curvivenia Gleason, sp. nov. Ramis, petiolis, foliorum pagina inferiore, spicis, et calycibus lepidibus brunneis pallide marginatis densissime obtectis; laminis obovatis vel obovato-oblongis abrupte argute acuminatis basi abrupte cuneatis supra opacis, venis lateralibus utrinque paullum elevatis a basi recurva sub angulo 80° adscendentibus; spicis ex axillis superioribus suberectis elongatis gracillimis; floribus omnino sessilibus 4-meris; calycis lobis triangulari-ovatis subacutis; corollae lobis tubo sublongioribus triangularibus dense pulverulentis; antheris sessilibus triangularibus ad basin corollae loborum insertis, rimis lateralibus dehiscentibus; ovario lepidoto conico in stylum subulatum abeunte.

Stems, petioles, lower leaf surface, inflorescence, and calyx very densely and closely covered with minute, brown, circular, appressed scales with paler margin; petioles 15 mm. long, angular when dry; blades obovate or obovate-oblong, 10–13 cm. long, 5–6 cm. wide, abruptly and sharply acuminate, broadly cuneate at base and somewhat decurrent on the petiole, opaque above; lateral veins recurved at base and thence spreading at an angle of about 80°; spikes very slender, 10–15 cm. long, solitary in the upper axils, nearly erect, the rachis angular; flowers sessile, 4-merous; calyx 1.6 mm. long, lobed to the middle, the lobes triangular-ovate, subacute; corolla (not fully expanded) 2 mm. long, lobed to slightly below the middle, densely pulverulent without and within, the lobes narrowly triangular; anthers sessile, inserted at the summit of the corolla-tube, triangular, 0.9 mm. long, basifixed, opening by lateral longitudinal clefts; ovary stoutly conic, lepidote, tapering above into a subulate style 0.6 mm. long.

Agüita, 3800 ft., *927*, flowers white. In leaf character it resembles *C. punctata* Mez, of Roraima, and is undoubtedly related to this species.

[1] With assistance of H. N. Moldenke.

The latter has a loosely branched inflorescence, with pedicels 2–3 mm. long, and lacks the peculiar recurved veins of our Duida plant.

Conomorpha duidae Gleason & Moldenke, sp. nov. Fruticosa, ramis apice dense ferrugineo-pulverulentis; foliis confertis; petiolis crassis superne alatis juventute dense ferrugineis; laminis crassis oblongis vel obovatis subacutis rotundatis vel emarginatis basi acutis vel acuminatis utrinque impresso-punctatis supra glabris nitentibus subtus primum stellato-pulverulentis; racemis subterminalibus, pedicellis brevibus stellato-pulverulentis; floribus 4-meris; calycis lobis late triangulari-ovatis obtusis vel subacutis punctatis; corollae lobis ovatis obtusis ad apicem atro-lineatis; staminibus ad faucem insertis, filamentis brevibus triangularibus, antheris triangularibus dorsifixis; ovario conico minute lepidoto.

Shrub 5 ft. tall; branches stout, dark and roughened; branchlets irregularly ridged, ferruginous-pulverulent toward the apex; leaves crowded at the tips of the branchlets; petioles stout, 12–25 mm. long, more or less winged above, densely ferruginous, becoming less so in age; blades dark, thick-coriaceous, oblong or obovate, 6–13 cm. long, 3–6.5 cm. wide, varying from obtusely acute to rounded or emarginate, entire, somewhat revolute in drying, acute or acuminate at base, glabrous and nitidous above, impressed-punctate on both surfaces, stellate-pulverulent beneath when young; midrib stout, very prominent to the apex on both surfaces, furrowed; secondaries extremely numerous, 20–40 or more pairs, usually conspicuous, straight and but slightly ascending, united 1–2 mm. from the margin by a rather conspicuous marginal vein; inflorescence racemose in rather irregular whorls near the tips of the branchlets, the rachides slender, 3–5 cm. long, each bearing about 4–10 flowers; flowers 4-merous; pedicels about 1 mm. long, densely stellate-pulverulent; calyx similarly pulverulent, but more sparsely; sepals united for about one-third or two-fifths of their length, the lobes very broadly triangular-ovate, about 1.3 mm. long and wide, obtuse or subacute, sparsely dark-punctate; petals yellow, united for about 1.1 mm. at base, the lobes ovate, about 1.9 mm. long and 1.5 mm. wide, obtuse, marked with a few dark lines and small stellate dots near the tip; stamens inserted on the corolla at the level of the petal-sinuses; filaments flat, triangular, about 0.7 mm. long, 0.6 mm. wide at base, glabrous; anthers triangular-ovate, 1.2–1.3 mm. long, acute, dorsifixed near the base, glabrous, their thecae slightly divergent toward the base, opening by longitudinal slits; gynoecium in male flowers acuminately conic, about 2.3 mm. long, minutely and obscurely lepidote, the ovary tapering gradually into the slender style; stigma not enlarged; fruit drupaceous, depressed-globose, about 5 mm. in diameter, hard, roughened, often apiculate, completely superior to the platter-shaped fruiting calyx.

Slopes and crest of Ridge 25, 5500–6000 ft., *421*, *466* (type). It is apparently closely related to *Schomburgk 1002* at Kew and Berlin, the type

of *C. latifolia* Mez, but this species differs from out plant in that it lacks the stellate hairs, has smaller and less numerous punctae and obviously acuminate leaves, its sepals more ciliate, and its petals scarcely punctate. It likewise seems to be related to *C. laxiflora* DC., but the latter lacks the characteristic venation of this species, has acuminate sepals, longer petioles, and narrower blades.

Conomorpha lepidota Gleason, sp. nov. Ramis, petiolis, foliorum pagina inferiore, spicis, et calycibus lepidibus brunneis pallide marginatis densissime obtectis; laminis coriaceis obovato-oblongis abrupte et obtuse acuminatis basi obtusis ad petiolum non decurrentibus supra subnitentibus, venis lateralibus supra obsoletis subtus perobscuris basi non recurvatis; spicis ex axillis superioribus patulis, folia paullum excedentibus; floribus omnino sessilibus 4-meris; calycis lobis ovato-rotundis subacutis; petalis nondum maturis ovatis glabris; staminibus ad basin corollae insertis, filamentis brevissimis, antheris late triangularibus; drupis nigris globosis punctatis.

Stem, petioles, lower leaf-surface, inflorescence, and calyx very densely and closely covered with minute, brown, circular, appressed scales with paler margin; stems sharply angled when young, soon becoming glabrous and subterete; petioles strongly channeled above, 8–10 mm. long; blades coriaceous, oblong-elliptic to obovate-oblong, broadest somewhat above the middle, abruptly acuminate to a blunt apex, subrevolute, obtuse at base, the upper surface yellowish green, minutely punctate, somewhat shining, glabrous; midvein impressed above, prominent beneath, the lateral veins obsolete above, obscure beneath, ascending at an angle of about 70°; staminate inflorescence spicate, from the upper axils, 4–5 cm. long, the rachis strongly angled, somewhat flexuous; staminate flowers strictly sessile, 4-merous; calyx-lobes ovate-rotund, subacute; immature petals ovate, glabrous; stamens attached to the base of the corolla, the filaments very short, the anthers basifixed, triangular-ovate, nearly as wide as long; pistillate spikes 2–3 cm. long; fruit black, spherical, densely punctate.

Dry crests of the Savanna Hills, 4400 ft., *741*. On one sheet bearing staminate flowers the leaves are 3–4 cm. long by about half as wide; a second sheet in fruit shows leaves as much as 7 cm. long by 3 cm. wide. It is related to *C. punctata* Mez, and differs from it and other species near it in having sessile flowers. In this character it resembles the preceding species, *C. curvivenia* Gleason, from which it is distinguished by small blunt leaves, shorter spikes, petals and sepals of a different shape, different venation, and general aspect.

CONOMORPHA PERUVIANA A.DC. Small tree on Agüita Slope, 4000 ft., *874;* slopes of Ridge 25, 5500–6000 ft., *435;* widely distributed in the Andes Mountains from Venezuela to Bolivia.

CONOMORPHA sp. A small tree from Agüita, 3100 ft., *901*, bearing young fruit only, has been tentatively referred to this genus. The leaves are obovate-lanceolate, long-acuminate, cuneate at base; the short spikes are axillary and extra-axillary, and the flowers are 4-merous.

CYBIANTHUS VENEZUELANUS Mez. A small tree at Agüita, 3100 ft., *884*, with white flowers and red fruits; heretofore known only from the coastal Andes of Venezuela.

GRAMMADENIA LINEATA Benth. Slopes of Ridge 25, 5500–6000 ft., *416*, a bush 4 ft. high with yellowish-white flowers; summit of Peak 7, 7100 ft., *612, 657;* known also from high altitudes on Mount Roraima.

Rapanea duidae Gleason, sp. nov. Ramis novellis angulatis minutissime puberulentibus mox teretibus glabris; petiolis brevibus; laminis coriaceis anguste obovatis rotundatis vel retusis ad basin longe angustatis supra nitentibus glabris subtus brunneis opacis minutissime pilosis; floribus immaturis in axillis fasciculatis 4-meris, antheris ovatis.

Young stems strongly angular and very minutely puberulent, soon becoming terete and glabrous; petioles rather stout, 4–6 mm. long, very minutely sericeous; blades coriaceous, narrowly obovate, 35–50 mm. long, 18–25 mm. wide, broadly rounded or usually retuse above, narrowed below to an acute base, yellowish-green, glabrous, and somewhat shining above; brown and very sparsely and minutely pilose beneath; lateral veins nearly obsolete, ascending at an angle of about 60°; flowers very immature, 4-merous, fascicled in the upper axils, the calyx sericeous, filaments very short, and anthers ovate.

Central Camp, 4800 ft., *594*. It is regretted that the immature flowers prevent more complete description, but there seems to be no doubt that it belongs to the genus *Rapanea* and is closely related to species 79 to 82, as numbered in Mez' monograph. Three of these are distinguished by their small leaves, only exceptionally as much as 25 mm. long, while the fourth, *R. acrantha* (Krug & Urban) Mez, of Jamaica, is glabrous and has membranous leaves.

SAPOTACEAE

Lowland species

SIDEROXYLON ELEGANS A.DC. A tree at Tarira, *1001;* a small tree at San Gabriel, on the Rio Negro, northern Brazil, *141*. The leaves of the latter number are much smaller than in the former, while its flowers are about a half larger in all dimensions. No other characters have been found to differentiate them and both are referred to the same species, which is widely distributed in the Guianas and Amazonian South America.

LOGANIACEAE

Lowland species

STRYCHNOS SMILACINA Benth. At edge of the river, Esmeralda, *310;* British and French Guiana.

Species of Mount Duida

Bonyunia cinchonoides Gleason & Standley, sp. nov. Frutex, ramulis dense hirtellis; foliis oppositis brevissime petiolatis coriaceis ellipticis vel ovato-ellipticis apice obtusis basi rotundatis; cymis subdensis, ramulis rigidis hirtellis, floribus subsessilibus; calyce glabro vel prope basin sparse hirtello, lobis anguste triangularibus attenuatis; capsula ellipsoideo-oblonga dense breviterque fulvo-pilosa.

A shrub, the branches rather slender but stiff, blackish, subterete, densely hirtellous, the internodes mostly 1.5–2 cm. long; leaves opposite, very shortly petiolate, stiff-coriaceous, glabrous, yellowish green, elliptic or ovate-elliptic, 3–4.5 cm. long, 1.7–2.8 cm. wide, very obtuse at the apex, rounded at the base, somewhat lustrous on the upper surface, the venation not elevated, scarcely paler beneath, the costa stout, prominent, the veins about 9 pairs, oblique, unequal, ascending at an acute angle, slender, prominent, anastomosing rather remote from the margin, the ultimate veins prominulous and laxly reticulate; cymes terminal, rather dense, in fruit about 7 cm. broad, many-flowered, pedunculate, the branches stiff, rigid, widely ascending, densely hirtellous; bracts oblong or linear, glabrous, 2–5 mm. long, spreading, the bractlets similar but smaller; flowers sessile or nearly so; calyx in fruit 4 mm. long, glabrous or sparsely hirtellous at base, lobed to the middle, the segments narrowly triangular, attenuate to an obtuse apex; capsule ellipsoid-oblong, 1.5 cm. long, obtuse at the base and apex, densely fulvous-pilose with short spreading hairs; seeds very numerous, pale, including the broad thin wing 5–8 mm. long, acute or acuminate at each end.

On ridge crests, Savanna Hills, 4400 ft., *770.* Of the genus *Bonyunia* three species have been described, one from the Serra da Chapada, Minas, Brazil, and the others from Mount Roraima. The plant collected on Duida is nearest *B. minor* N. E. Brown, of Roraima, the latter differing in its glabrous branches, acutish leaves, and slightly smaller capsules.

Bentham and Hooker do not describe the seeds of *Bonyunia,* but Progel, in the Flora Brasiliensis, states that they are "aptera." In *B. cinchonoides* the body of the seed is small, but it is surrounded by a thin and broad wing. Probably it is so in all the members of the genus.

GENTIANACEAE[1]

Lowland species

CHELONANTHUS ANGUSTIFOLIUS (HBK.) Gilg. Esmeralda, in open savannas, *181;* in grassy savanna bordering sandstone ridges, *169*. The plants are identical with the type, collected at Esmeralda by Bonpland. Other plants referred here have been collected in the Andes at moderate altitudes from Tarapoto, Peru, to northern Colombia.

CHELONANTHUS CAMPANULOIDES (Spruce) Gilg. In savannas and swampy ground at Esmeralda, *179*, *298*, *302;* known only from Esmeralda and the upper Rio Negro.

CHELONANTHUS CHELONOIDES (L.f.) Gilg. River banks and flood sands, Muyrapenima, on the Rio Negro, northern Brazil, *73;* widely distributed through tropical South America as a weed in clearings.

CHELONANTHUS SPRUCEANUS (Benth.) Gilg. Yucabí, on the Rio Negro, northern Brazil, *132;* distributed along the upper Amazon and the Rio Negro.

COUTOUBEA SPICATA Aubl. Grasslands at Esmeralda, *237;* a common species of the lowlands of northeastern South America.

CURTIA TENUIFOLIA (Don) Knobl. On wet savannas at Esmeralda, *253;* widely distributed through Amazonian South America, especially on savannas. Our specimen is precisely the same as *Spruce 3242*, also from Esmeralda, and both differ from the usual form of the species in their smaller leaves and much reduced inflorescence.

Species of Mount Duida

Calolisianthus Tatei Gleason, sp. nov. Caulibus erectis subteretibus glabris, ramis paucis, internodis superne gradatim elongatis; foliis subsessilibus coriaceis ovatis ad apicem apiculatum angustatis, basi rotundatis, in sicco rugosis, venis lateralibus obsoletis; paniculis sparse ramosis flexuosis, pedicellis calyces subaequantibus; calycis lobis late rotundatis; corollae lobis erectis late ovatis apice brevissime apiculatis.

Stems erect, simple or sparingly branched, subterete, marked with four low ridges extending down from each node; petioles very broad, about 2 mm. long, those of each pair connected by a membrane 1 mm. wide; leaves coriaceous, narrowly ovate, as much as 45 mm. long by 25 mm. wide, the upper progressively smaller, acute, with the midvein prolonged into an apiculum 1–2 mm. long, rounded at the base but broadly and cuneately decurrent on the petiole, brownish green and rugose when dry, somewhat shining above; midvein prominent on both sides, the lateral veins obsolete or nearly so;

[1] With the collaboration of R. P. Wodehouse.

inflorescence simple or with 2 or 3 branches, the racemes elongating in fruit to as much as 20 cm., but usually much shorter, few-many-flowered; pedicels 5 mm. long at anthesis, alternate, subtended by a pair of minute triangular opposite bracts; calyx 4–4.5 mm. long, the sepals ovate-lanceolate, broadly rounded above; corolla nearly 2 cm. long, the lobes broadly triangular-ovate, 3.5–4 mm. long, minutely apiculate; capsule narrowly ovoid-oblong, the body nearly 10 mm. long, tipped by the persistent style of the same length.

Dry crests of Savanna Hills, 4400 ft., *743* (type), with pink flowers; Brocchinia Hills, 4500 ft., *587*, an herb 3 ft. tall with pink-magenta flowers. Among the comparatively few species of this genus, only two or three exhibit the essentially veinless leaves and general habit of our species. Of these, *C. pulcherrimus* (Mart.) Gilg approaches ours, but has leaves subcordate at base and fewer flowers which are more than twice as large and orange-red in color.

Chelonanthus pyriformis Gleason, sp. nov. Caulibus erectis parce ramosis superne paullum 4-angulatis, internodis superne gradatim elongatis; foliis suberectis membranaceis lineari-lanceolatis longe acuminatis ad basin sessilem cuneatis, venis lateralibus a quoque latere 1 vel 2; inflorescentia simplice vel bifurcata pauciflora, bracteis adpressis ovatis; calycibus pyriformibus pedicellos angulatos subaequantibus vel paullum excedentibus, lobis tubo multo longioribus late ellipticis superne rotundatis, medio area elevata vel umbonata notatis, margine membranaceis; corolla supra basin angustata superne tubuloso-dilatata.

Stems erect, sparingly branched, subterete, or marked with 4 obscure ridges, or roundly 4-angled with shallowly sulcate sides, the lower internodes 3 cm. long, progressively increasing distally; leaves suberect, sessile, connected at base by a membrane 1 mm. wide; blades membranous, linear-lanceolate, 40–60 mm. long, 8–12 mm. wide, sharply long-acuminate, cuneate at base, somewhat rugose when dry; midvein plane above, elevated beneath, the lateral veins obscure, 1 or 2 on each side; inflorescence simple or bifurcate, each raceme 5–9-flowered, elongating in fruit to 20 cm., pedicels at anthesis about 5 mm. long, becoming 10 mm. long in fruit, subtended by a pair of ovate, obtuse, appressed, bracts 2–3 mm. long; calyx pyriform, 8 mm. long, its lobes broadly elliptic, 5 mm. long, broadly rounded at the summit, membranous at the margin, strongly concave or umbonate toward the middle; corolla yellow, 3 cm. long, strongly constricted above the base and thence gradually dilated distally, its lobes broadly triangular-ovate, somewhat erose; capsule ellipsoid, 17 mm. long, the persistent style 5–7 mm. long.

Dry crests of Savanna Hills, 4400 ft., *747*. The species is related to *C. camporum* Pilger, of similar altitudes in Peru, in which the sepals are thinner, less rounded, and without the convex back, and the corolla is greenish white.

Chorisepalum Gleason & Wodehouse, gen. nov.

Flores solitarii terminales 6-meri. Sepala ad basin distincta, elongata, disco nullo. Corolla tubulosa, lobis ellipticis aristatis dimidium tubi aequantibus. Stamina prope basin corollae inserta tubum paullum excedentia; filamentis elongatis, antheris linearibus. Ovarium anguste lineare 2-loculare; stylo elongato, stigmate bifido. Frutices, caulibus nodosis annulatis, foliis coriaceis petiolatis.

Flowers solitary, terminal, 6-merous. Sepals narrow, distinct to the base; disc none. Corolla tubular, its lobes elliptic, aristate, half as long as the tube. Stamens attached near the base of the corolla-tube and slightly exceeding it; filaments elongate, anthers linear. Ovary linear, completely 2-celled by the intruding placentae; style slender, equaling the stamens; stigma bifid, its lobes narrowly elliptic. Glabrous shrubs, with nodose annulate stems and opposite, coriaceous, petiolate, entire leaves.

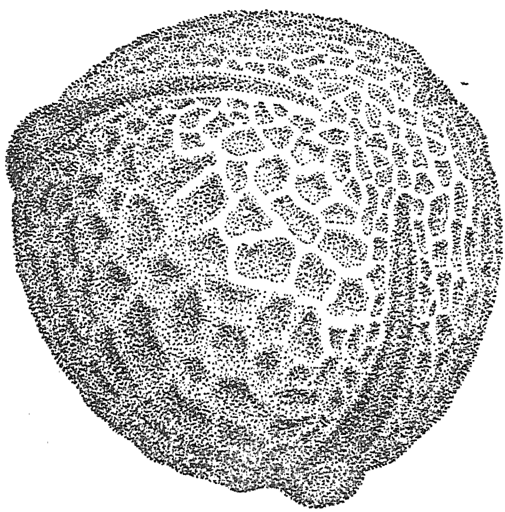


Fig. 5. Pollen-grain of *Chorisepalum ovatum* ×2000.

Pollen grains uniform in size and shape, ellipsoidal when dry, oblate when moist and expanded, 30.8–34.2μ in diameter, tricolpate, the furrows long and tapering to rounded ends, gaping widely open as the grain expands; furrow-membranes smooth or slightly flecked; germinal apertures circular and well defined, marked by a barely perceptible annular thickening surrounding the pore, which bulges prominently through it; surface of the general exine covered with a heavy reticulum which is coarsest towards the center of the lunes, somewhat finer toward the margins of the furrows, along which it ends abruptly with closed lacunae, and much finer toward the poles. (Fig. 5.)

The generic name refers to the distinct sepals, a character of rare occurrence in the Gentianaceae.

Chorisepalum ovatum Gleason, sp. nov. Foliis ovalibus obtusis basi rotundatis subaveniis; sepalis anguste oblongis obtusis.

Leaves oval, 4.5–7 cm. long, 3–4 cm. wide, abruptly narrowed to a small, triangular, obtuse apiculum, rounded at base, the midvein impressed above, elevated beneath, the lateral veins obscure; sepals narrowly oblong, 3 cm. long, obtuse; corolla-tube 4 cm. long, its lobes 2.5 cm. long, 1.5 cm. wide, acute and tipped with an arista 5 mm. long; filaments slender, 3 cm. long, inserted 1.5 mm. above the base of the corolla-tube; anthers 7 mm. long; ovary narrowly linear, 12 mm. long, the placentae meeting in the middle and there bifurcate and recurved to simulate a 2-celled ovary with central placentae; style slender, 3 cm. long; lobes of the stigma obtuse, 5 mm. long.

Base of the slope of Ridge 25, 5200 ft., *462*, described by the collector as a straggling shrub 8 ft. high, with large, green, tubular flowers. The specimen bore a single flower only.

Chorisepalum is clearly a member of the Gentianaceae, as shown by its contorted corolla, its opposite, entire leaves, its bicarpellate ovary with elongate style and bifid stigma, and its distinctly gentianaceous pollen. Its peculiar features are chiefly the separate sepals, the 6-merous flowers, and the completely 2-celled ovary. The first of these is essentially duplicated in *Zygostigma*, a genus which differs widely in general facies; the second is probably not of great taxonomic importance, and the third is found also in the monotypic *Rusbyanthus*. Our plant probably finds its nearest relative in this genus, now known only from the mountains of Bolivia. *Rusbyanthus* differs in its well developed calyx-tube with broad lobes, its numerous flowers in cymose clusters, and its large thin leaves. *Macrocarpaea*, a genus of Andean shrubs, includes several species which resemble *Chorisepalum* in general habit, including the conspicuous annular leaf-scars and the small oval leaves; all of them have a prominent calyx-tube with usually short and rounded lobes, none of them have aristate petals, and the ovary is invariably one-celled.

SYMBOLANTHUS QUELCHII (N. E. Br.) Gleason. Crest of Ridge 25, 6300 ft., *860;* otherwise known only from Mount Roraima.

APOCYNACEAE[1]

Lowland species

MANDEVILLA SCABRA (R. & S.) K. Sch. Tinahy, on the Rio Negro,

[1] By Robt. E. Woodson, Jr.

northern Brazil, *115*, a nearly glabrous specimen of this variety, otherwise typical; central and northeastern South America.

Mandevilla subcarnosa (Benth.) Woodson, comb. nov. *Echites subcarnosa* Benth. Hook. Jour. Bot. **3**: 247. 1841.

Rocky top of Esmeralda Ridge, *188;* also known from Mount Roraima. This species is typically somewhat voluble, as indicated by the type specimen, *Schomburgk 183* (Herb. Kew.). More or less erect, suffruticose individuals also occur within the limits of the species, however, and have formed the chief basis of *M. Dielsiana* Mgf. *Tate 188* is evidently a specimen of such a suffruticose individual.

PLUMIERIA PURPUREA R. & P. River banks and flood sands at Muyrapenima, on the Rio Negro, northern Brazil, *65;* generally distributed in the upper Amazon valley.

TABERNAEMONTANA CITRIFOLIA Jacq. At Muyrapenima, *63;* commonly cultivated in tropical America.

TABERNAEMONTANA CORONARIA (Jacq.) Willd. A large bush at Piedra Alta, on the Rio Negro, northern Brazil, *148;* of uncertain nativity, commonly cultivated in tropical America.

Species of Mount Duida

COUMA UTILIS Muell.-Arg. Small tree with red flowers and milky juice, dry slopes of Savanna Hills, 4400 ft., *732;* a native of the upper Amazon valley.

Salpinctes Woodson, gen. nov.

Calyx profunde 5-partitus; laciniae aequales vel subaequales margine imbricatae basi intus multiglandulosae. Corolla speciosa; tubus cylindricus nunquam constrictus propre basin staminiger; limbi laciniae 5 dolabriformae aestivatione dextrorsum imbricato-convolutae valde reflexae. Stamina 5 fere basi corollae inserta inclusa cum corollae sequentis alternatis; filamenta subfiliformia; antherae inter se plus minusve adglutinatae et in cono cohaerentes stigmati adplicatae sagittatae oblongo-ellipsoideae parte dimidia superiore pollinigerae basi acuto-bilobae; microsporangia basi sterilia; pollen granulosum. Nectaria 2 integra. Ovaria gemina lobis singularibus unilocularibusque, ovulis in quoque loculo binis superpositis; stylus filiformis gracilis; stigma fusiforme 5-gonum apice obscuro bipartito. Fructi folliculares apocarpi lineari-cylindrici plus minusve falcati; semina numerosa subscaphoidea longitudinaliter unisulcata apice comosa. Suffrutices; folia opposita vel subverticillata coriacea eglandulosa; inflorescentia terminalis uniflora.

Salpinctes kalmiaefolius Woodson, sp. nov. Suffruticosa erecta vel suberecta pauce ramosa 2–5 dm. alta; ramis erectis vel suberectis subcompressis

nitidulis; foliis breviuscule petiolatis vel subsessilibus oblongo-ovatis 2–4 cm. longis 7.5–10 mm. latis glabris coriaceis margine revolutis; lobis calycis ovato-lanceolatis scariaceis 4.5–5 mm. longis intus multiglandulosis; lobis corollae obovatis dolabriformibus 2.5–3 cm. longis apice 1.5–2 cm. latis valde reflexis, tubo longe cylindrico 2.5–3.5 cm. longo; bracteis minimis late triangulari-ovatis ca. 1 mm. longis; folliculis ignotis (Pl. 37).

Erect woody herb with milky juice, corolla pink, trumpet-shaped. Dryish slopes of Savanna Hills, 4400 ft., *836* (photograph and analytical drawings in herb. Missouri Bot. Gard.).

Salpinctes (?) **duidae** Woodson, sp. nov. Suffruticosa erecta vel suberecta pauce ramosa 1.5–3 dm. alta; ramis erectis vel suberectis subcompressis minute scabro-bullatis; foliis oppositis vel subverticillatis breviuscule petiolatis vel subsessilibus oblongo-linearibus 3–6 cm. longis 2–4 mm. latis glabris coriaceis margine revolutis; folliculis erectis cylindrico-fusiformibus haud torulosis ca. 10–12 cm. longis glabris. Flores ignoti.

Dry ridge tops, Savanna Hills, 4400 ft., *805* (photograph in Herb. Missouri Bot. Gard.).

The genus *Salpinctes* may be regarded as one of the most remarkable genera of American Echitoideae. Although closely related to *Echites* (*sensu strictiore*), *Stipecoma*, and *Macropharynx*, *Salpinctes* differs from all in its solitary terminal flower, evidently representing a reduction from a multiflorous inflorescence, its coriaceous, strongly revolute foliage, its geminate nectaries, and its suffrutescent habit. In the number of nectaries, *Salpinctes* resembles the less closely related *Dipladenia*, from which it differs in the structure of the inflorescence, microsporangia, and clavuncle or stigmatic head. These are indeterminate, wholly fertile, and umbraculiform, respectively, in *Dipladenia*, and determinate, basally produced into a conspicuous, inwardly protuberant, sterile projection, and fusiform, respectively, in *Salpinctes*. The foliage of the latter genus, moreover, strongly suggesting that of the ericaceous genus *Kalmia*, is at present unknown in species of the former.

Although the type specimen of *S. kalmiaefolius* bears flowers only, the fruiting characteristics of the genus have been ascertained from the type specimen of *S. duidae*, which, although without flowers, possesses all other morphological characters of the genus. The generic name has been taken directly from the Greek σαλπιγκτής, referring to the solitary, terminal, trumpet-shaped flower.

ASCLEPIADACEAE[1]

Lowland species

ASCLEPIAS CURASSAVICA L. Second growth along river bank, Cravoeiro, on the Rio Negro, northern Brazil, *75;* widely distributed through tropical America.

Blepharodon venezuelense Moldenke, sp. nov. Caule erecto vel subvolubile glabro; petiolis elongatis glabris; laminis ovatis acutis vel acuminatis saepe apiculatis basi acutis utrinque glabris aut ad marginem basalem pauciciliatis, supra ad basin nervi medii glandula bifida ornatis; inflorescentia axillare pauciflora; pedunculis elongatis gracillimis glabris saepe flores paucos abortivos gerentibus; pedicellis florum evolutorum multo elongatis filiformibus glabris; calyce campanulato; sepalis ovatis margine tenuioribus glabratis eglandulosis; petalis ovato-oblongis acutis estus minute pulverulentis intus glabris basi connatis; corona simplice ad basin gynostegii adnata membranacea, segmentis ovato-lanceolatis integris; filamentis brevissimis glabris; antheris quadrangularibus crista inflexa semicirculare hyalina paullum undulata superatis; stigmate pentagono medio depresso.

Stems slender, erect to vine-like, glabrous; internodes 0.5–2 cm. long on young shoots, to 9 cm. long on older stems; leaves opposite, often with a gland-like structure between or just below; petioles 3–8 mm. long, glabrous; blades firm, rather dark in drying, ovate, 2–4 cm. long, 0.5–1.5 cm. wide, acute or acuminate, sometimes apiculate, slightly revolute in drying, acute at base, glabrous on both surfaces or with a few scattered cilia along the basal margins, with a distinct bilobed gland on the upper surface near the base of the midrib; inflorescence axillary, few-flowered; peduncles very slender, 4–6 mm. long or longer, glabrous, often somewhat irregular in shape and bearing several developed and a few abortive flowers; pedicels of developed flowers filiform, 9–14 mm. long, glabrous; calyx campanulate, about 4 mm. in diameter; sepals ovate, about 1.3 mm. long and 1.05 mm. wide, thinner at margins, glabrate, eglandular; petals ovate-oblong, acute, minutely pulverulent without, glabrous within, about 4.7 mm. long and 2.6 mm. wide, connate at the base; corona simple, very thin-textured, attached to the base of the gynostegium, its segments ovate-lanceolate, about 2 mm. long and 0.7 mm. wide, entire; filaments very short, about 0.65 mm. long and wide, glabrous; anthers quadrangular, about 2.5 mm. long and 1.5 mm. wide, surmounted by a somewhat wavy-margined, semicircular, incurved, hyaline crest which is about 1 mm. wide and 0.5 mm. long; corpuscula large, dark, about 0.5 mm. long and 0.25 mm. wide; stigma pentagonal, about 0.6 mm. long and wide, depressed in the center.

Tree Savannas, Esmeralda, *325*. It seems to be related to *B. bracteatum*

[1] With collaboration of H. N. Moldenke.

Fourn. in having a single corona, but the latter differs conspicuously in its long floriferous branches which are leafless at the apex, its much larger and cuneate leaves which are pilose on the margins, its longer petioles, its lanceolate sepals, and its barbate petals. It likewise resembles *B. longipedicellatum* Fourn., which, however, differs in its much larger leaves with long-acuminate or cuneate base, its 3 glands in each sepal-sinus, and its 4-lobed corona.

Ditassa Tatei Gleason & Moldenke, sp. nov. Caule volubile leviter albo-pubescente in lineis 2 oppositis; foliis oppositis, pluribus ad ramos juveniles confertis; petiolis 1–2 mm. longis; laminis linearibus ultra medium latioribus apiculatis in siccitate revolutis basi rotundatis utrinque glabris; inflorescentia umbellata axillare pedunculata; floribus 3–5 pedicellatis; sepalis paene distinctis ovatis obtusis glabris ad medium herbaceis ad marginem scariosis; corolla campanulata alba; petalis ad partem tertiam aut quartam connatis subacutis subtus glabris supra minute papillosis; coronae exterioris segmentis varie alteque 3-lobatis, saepe prope ad basin, gynostegium aequantibus; corona interiore ad basin staminum adnata, segmentis oblongo-lanceolatis planis acutis; antheris quadratis crista incurvata hyalina superatis; folliculis gracilibus stipitatis glabris.

Stems twining, lightly white-pubescent in 2 opposite lines proceeding upward from between the leaves at each node; internodes 1–3.5 cm. long, or much shorter on the young shoots; leaves opposite, numerous, closely crowded on the young shoots, petiolate; petioles 1–2 mm. long, glabrate; blades dark above, lighter beneath, linear, usually broadest beyond the middle, 9–20 mm. long, 1–2 mm. wide, obtuse or acute, apiculate, revolute in drying, rounded at base, glabrous on both surfaces, midrib prominent beneath; inflorescence umbellate, axillary, often subtended by a cluster of small linear bracts 5–7 mm. long; umbels 3–5-flowered; peduncles 1–2 mm. long, glabrous; pedicels 1–1.5 mm. long, glabrous; sepals almost wholly separate, ovate, obtuse, about 0.8 mm. long and 0.6 mm. wide, glabrous, scarious-margined, herbaceous in the middle; corolla campanulate, white; petals ovate, about 1.6 mm. long and 0.8 mm. wide, connate for a third or a fourth their length, subacute, glabrous without, minutely papillose within; exterior corona about 0.8 mm. long, its 5 segments deeply but irregularly 3-lobed, often nearly to the base, the lobes triangular, acute, about equaling the gynostegium; interior corona at base of stamens, segments oblong-lanceolate, flat, about 0.45 mm. long and 0.2 mm. wide, shorter than the anthers, acute; anthers trapezoidal, about 0.5 mm. long, surmounted by an incurved hyaline crest which is about 0.4 mm. long and wide; pollinia about 0.35 mm. wide, its sacs each about 0.25 mm. wide and its corpuscula about 0.1 mm. long; follicles slender, about 3 cm. long, stalked, glabrous.

Esmeralda, *199*. This is apparently the same as *Spruce 3226* at Kew,

labeled "Ad Esmeraldam in montibus humidioribus. Herba vel suffrutex volubilis. Flores albi.", to which an unknown hand has added "Ditassa sp.n. Cor. stam. lobi exteriores 3-fidi laciniis. Gynostegium subsuperantes interiores breviores lanceolati." It also appears to be identical with *Schomburgk 915*, which at Berlin is under the label *Metastelma guianense* Kl. It seems to be related to *D. eximia* Dcne., but the latter differs conspicuously in its glandular leaf-bases, its leaves rounded or emarginate at the apex, its subsessile umbels, its glandular sepals, its exterior corona lobes exceeding the gynostegium, and its much longer petioles.

Metastelma strictum Gleason & Moldenke, sp. nov. Caulibus gracilibus dense breviterque pubescentibus, internodis paullum elongatis; foliis petiolatis; laminis linearibus apiculatis in siccitate revolutis basi obtusis truncatisve supra et ad venam mediam subtus dense breviterque pubescentibus; floribus in axillis foliorum superiorum fasciculatis, pedicellis glabratis; sepalis ovato-lanceolatis acutis ad dimidium connatis externe plerumque pilosis; corollae campanulatae lobis ovato-lanceolatis supra superne dense hirsutis; corona ad basin gynostegii adnata, lobis duplicibus integris acutis interno superne libero et externi dimidium aequante; antheris sessilibus quadratis inappendiculatis ad lateres superne minute acutatis.

Stems several, slender, 28–52 cm. tall, strict or sparingly branched, densely short-pubescent throughout; internodes 1.5–5.5 cm. long; petioles about 1 mm. long, short-pubescent; blades linear, 11–21 mm. long, 1.5–3 mm. wide, apiculate, revolute in drying, obtuse or truncate at base, densely short-pubescent above and on the midrib beneath; flowers white, fasciculate in the axils of the upper leaves; fascicles 1–5 or more flowered, subtended by numerous scale-like bractlets; peduncles obsolete or at least not apparent; pedicels about 0.7 mm. long, glabrate; sepals ovate-lanceolate, about 1.3 mm. long, acute, connate to nearly the middle, mostly pilose without; corolla campanulate, its lobes spreading, ovate-lanceolate, about 2.2 mm. long, densely hirsute on the distal third within; corona 5-lobed, attached to the base of the gynostegium, its lobes apparently double, not cleft, about 0.8 mm. long and 0.6 mm. wide, acute, the inner one free at the top only and about half as long as the outer; anthers trapezoidal, about 0.5 mm. long, essentially sessile, not appendaged, but ending in 2 minute lateral triangular points; pollinia about 0.2 mm. long; follicles slender, 3.5–4 cm. long, stalked, puberulent, the stalks with a whorl of bractlets at the base and apex.

Esmeralda, *262* (type). Number *295*, collected at Grand Savanna, Section 1, Esmeralda, is apparently the same, as is also *Spruce 3258*, collected on the plains about Esmeralda, to which at Kew an unknown hand has added: "Cor. tom. foliola ovata acuta gynostegio basi inserta et eum superantis." It appears to be related to *M. obscurum* Fourn., but the

latter differs conspicuously in being green-tomentose throughout, in having no pedicels, and in having the corona-lobes 3-dentate at their apex.

Species of Mount Duida

Blepharodon ciliatum Moldenke, sp. nov. Caule gracile volubile in lineis 1 vel 2 pubescente; foliis oppositis petiolatis; laminis tenuibus ovatis abrupte acuminatis vel mucronatis, in sicco paullum revolutis, basi acutis et paullum infundibuliformibus ad marginem ciliis arcuatis ornatis; inflorescentia axillare 1-pauciflora nutante, pedunculis saepe fasciculum florum sessilium abortivorum gerentibus, flore evoluto 1 longe pedicellato; calyce campanulato basi incrassato; sepalis crassis ad margines tenuioribus, triangularibus, glabris, basi connatis; corolla rotata; petalis membranaceis late ovatis breviter acuminatis 7-nerviis extus glabris intus breviter pubescentibus; corona duplice, exteriore ad basin gynostegii adnata, segmentis anguste ovatis acutis gynostegium multo superantibus; segmentis interioris ad exteriorem adnatis lanceolatis subacuminatis gynostegium subaequantibus; filamentis basi dilatatis; antheris obverse triangularibus crista hyalina semicirculare ornata; stigmate umbonato.

Small twining vine; stems slender, with 1 or 2 lines of pubescence running down from between the leaves at each node; internodes 2–3.5 cm. long; juice milky; leaves opposite; petioles 2.5–4 mm. long, glabrous; blades thin, dark above, much lighter beneath, ovate, 20–38 mm. long, 5–9 mm. wide, abruptly acuminate or apiculate, somewhat revolute in drying, acute and slightly funnel-form at base, the margins at the base fringed with a row of arched cilia; inflorescence axillary, 1–few-flowered, drooping; peduncles about 6 mm. long, slender, glabrous, pendent, often terminated by a small cluster of abortive flowers and only 1 developed flower; pedicels of developed flowers about 8 mm. long, glabrous, of abortive flowers obsolete; calyx campanulate, about 3.5 mm. in diameter, incrassate at base; sepals 5, thin at the margins, thick in the middle, triangular, united only at the base, about 1.5 mm. long and 1 mm. wide, glabrous; corolla rotate, about 1.4 cm. in diameter; petals 5, thin, broadly ovate, short-acuminate, thinner along the margins toward the apex, somewhat narrowed toward the base, about 5.6 mm. long and 3.2 mm. wide, 7-nerved, glabrous without, short-pubescent within; exterior corona attached to the base of the gynostegium, its segments 5, alternate with the petals, narrowly ovate, greatly surpassing the gynostegium, acute, about 3.4 mm. long and 1.8 mm. wide; interior corona attached to the exterior but much smaller, its segments lanceolate, about 1.4 mm. long and 0.65 mm. wide, subacuminate, barely equaling the gynostegium; filaments about 0.7 mm. long, about 1.3 mm. wide at base and 0.8 mm. wide at apex; anthers obversely triangular, about 0.8 mm. wide and long, surmounted by a semicircular hyaline crest which is about 0.5 mm. long and wide; pollinia about 0.65 mm. wide, its sacs about 0.4 mm. long, its corpuscula dark, about 0.25 long and 0.1 mm. wide; stigma umbonate.

Dry slopes of the Savanna Hills, 4400 ft., *748*. It is apparently related to *B. pallidum* Dcne., but the latter differs conspicuously in its glabrous stems, its leaves with rounded bases, its ciliate midrib, its very short peduncles, its pilose-ciliate corolla-lobes, and its short and obtuse exterior corona segments.

Blepharodon Hitchcockii Gleason, sp. nov. Caule volubile flexuoso laxe foliato glabro; foliis breviter petiolatis reflexis crassis ellipticis in mucronem abrupte angustatis basi subcordatis glabris; racemis axillaribus 5–8-floris pedicellis gracilibus; calycis lobis ovatis obtusis ciliatis margine scariosis; corollae lobis fere ad medium connatis triangularibus acutis extus glabris intus dense sericeis; coronae lobis basi connatis oblique cupuliformibus ad gynoecium adpressis, exterioris brevioribus acuminatis, interioris rotundatis; antheris quadratis apiculatis appendice hyalina semicirculare incurvata cristatis.

Stem flexuous, twining, glabrous, the internodes exceeding the leaves; petioles glabrous, 3–4 mm. long; leaf-blades thick, nigrescent when dry, elliptic, 3–4 cm. long, 13–18 mm. wide, slightly revolute, subcordate at base, abruptly narrowed into a rigid mucro 3 mm. long, the margin cartilaginous, midvein obscure, with a minute gland at its base, lateral veins evanescent, glabrous on both sides and rugose, at least when dried; inflorescences racemose, 2–4 cm. long, 5–8-flowered, from the upper axils, the slender pedicels 6–10 mm. long and glabrous; calyx somewhat glandular at base, 4 mm. in diameter, its lobes ovate, 1.6 mm. long, 1.2 mm. wide, obtuse, herbaceous in the center, scarious at the margin, finely ciliate; corolla rotate, 10 mm. in diameter, its lobes triangular, 3 mm. long and about as wide, acute, 5-nerved, glabrous without, densely sericeous within; corona attached to the gynoecium, its five lobes conic and hollow, each bearing an outer lanceolate lobe and an inner longer rounded lobe about equaling the anthers and appressed to them; anthers nearly square, 1.1 mm. long, tipped with a hyaline, incurved, semicircular appendage 0.5 mm. long; stigma pentagonal, umbonate in the center.

Dry slopes of Savanna Hills, 4400 ft., *753;* the name commemorates Mr. Chas. B. Hitchcock, geologist of the expedition. The plant resembles *B. crassifolius* Schltr., of high altitudes on Roraima, but has flowers of half the size.

Ditassa duidae Gleason, sp. nov. Frutex volubilis, ramis pubescentibus; foliis numerosis confertis brevipetiolatis obovato-oblongis basi cuneatis apice rotundatis apiculatis margine recurvatis; umbellis axillaribus paucifloris subsessilibus; pedicellis brevibus; calycis lobis glabris ovatis; petalis ovato-lanceolatis; corona exteriore basi cyathiforme, lobis ovatis acuminatis margine valde incurvatis, interiore hyalina, lobis linearibus adscendentibus; antheris membrana semicirculare cristatis.

Stems freely and diffusely branched, the branches long and slender, densely leafy, pubescent when young with short spreading hairs, tardily glabrescent with age, the internodes seldom exceeding 1 cm.; petioles stout, 1 mm. long, sometimes subtended by fleshy circular glands; leaf-blades ascending, coriaceous, narrowly obovate-oblong, 10–16 mm. long, 3–5 mm. wide, broadly rounded or subtruncate above to an apiculate tip, strongly revolute, acute at base, glabrous throughout or sparsely pilose on the midvein beneath, the latter impressed above and elevated beneath, the lateral veins few and obscure; inflorescence of numerous axillary umbels, the peduncles 1 mm. long, the pedicels 3–5, 2–3 mm. long, very sparsely pilose; sepals ovate, 1.1 mm. long, connate for a third of their length, acute or acutish, glabrous, membranous at the margin; corolla campanulate, 3 mm. long, the glabrous, ovate-lanceolate, acute lobes connate for a third of their length; corona double, the outer 2 mm. long, the 5 lobes connate for about 0.5 mm. at base, ovate, acuminate, the lateral margins strongly incurved and overlapping, the inner of 5 linear, membranous, ascending lobes 0.7 mm. long attached to the base of the filaments; anthers 0.6 mm. long, deeply lobed at base, tipped with a hyaline semicircular incurved appendage slightly surpassing the stigma; pollinia pendent, nearly linear, 0.35 mm. long, the translator arms less than 0.1 mm. long, the corpusculae 0.2 mm. long.

Summit of Peak 7, 7100 ft., *601*, *648* (type), and *649*. It is stated to be a vine with small white flowers, but only a few stems show any present evidence of twining. It is related to *D. retusa* Mart. & Zucc., of the mountains of southern Brazil, which resembles ours in habit but has larger leaves on much longer petioles, glandular calyx and rounded sepals, and fleshy, incurved inner corona.

Metastelma mirifolium Gleason & Moldenke, sp. nov. Caulibus superne dense breviterque albo-pubescentibus glabrescentibus, internodis brevissimis; foliis confertis petiolatis; petiolis alte canaliculatis ad marginem albo-ciliatis, marginibus superne inflexis et connatis; laminis lineari-lanceolatis argute apiculatis, insigniter revolutis prope ad basin plus minus infundibuliformem, ubi marginibus inflexis et cum alis petioli contiguis, supra glabris subtus sparsissime pilosis; floribus in axillis superioribus fasciculatis, pedunculis brevissimis vel nullis; pedicellis bracteatis pubescentibus; sepalis ovato-lanceolatis ad tertiam partem connatis acutis sparsissime pilosis; corolla campanulata ad medium tubulosa; petalis ovato-oblongis acutis extus glabris intus in lineis 2 intramarginalibus pilosis; corona simplice ad basin corollae adnata, segmentis triangulari-lanceolatis acutis; filamentis basi angustis superne latis; antheris quadratis appendiculo inflexo hyalino ornatis.

Stems strict, 30–60 cm. tall, densely and shortly white-pubescent above, becoming glabrate below; internodes 0.5–2.5 cm. long; leaves numerous, crowded, petiolate; petioles 1.5–3 mm. long, deeply canaliculate, the margins fringed with a row of short whitish cilia, infolded and uniting above, causing

the petiole to appear to have a double median row of hairs; blades linear or linear-lanceolate, sharply apiculate, strongly revolute almost to the base, which is more or less funnel-form, being inflexed and contiguous with the infolded wings of the petiole, 10–24 mm. long, 2–4 mm. wide, glabrous above and essentially so beneath except for a few whitish cilia sometimes extending up the two margins at the base and some occasional scattered hairs on the midrib; flowers fascicled in the extreme upper axils, "whitish in bud"; peduncles obsolete or to 0.5 mm. long; pedicels slender, about 2.3 mm. long, pubescent; bractlets arranged in a whorl at the base of the fascicle, subulate, about 1.3 mm. long or longer, acute or acuminate; sepals 2.5 mm. long from the base, connate for about 0.7 mm. their length, the free portion ovate-lanceolate, about 1.8 mm. long and 0.8 mm. wide, acute, very sparsely pilosulose, eglandular; corolla campanulate, about 3.2 mm. long; petals ovate-oblong, connate to the middle, acute, glabrous without, densely pilose within on 2 thickened intramarginal lines, the margin being glabrous to the very base; corona simple, attached to the base of the corolla, its segments triangular-lanceolate, about 1.1 mm. long and 0.5 mm. wide, acute, slightly revolute, glabrous; filaments about 0.3 mm. long, about 0.32 mm. wide and 0.28 thick at the base, about 0.7 mm. wide and 0.28 mm. thick at the apex, about 1.5 mm. thick at the middle; anthers trapezoidal, about 0.85 mm. long and wide at the base and 0.5 wide at the apex, surmounted by a hyaline incurved appendage about 0.5 mm. long; pollinia about 0.3 mm. long; follicles slender, 2 cm. long or longer, stalked, pubescent, the stalk with a whorl of bractlets at its base and apex.

Ridge crest, Savanna Hills, 4400 ft., *767*. This species is apparently related to *M. strictum* Gleason & Moldenke, but the latter differs very markedly in its much sparser leaves which are pubescent above, much more uniform in width, truncate at base, and totally without the peculiar infundibular basal margins and channeled petiole which so prominently characterize this species. It likewise differs in its double corona-lobes and its sessile unappendaged anthers.

CONVOLVULACEAE

Lowland species

JACQUEMONTIA GUYANENSIS (Aubl.) Meissn. In forest, Santa Isabel on the Rio Negro, northern Brazil, *95;* a common species throughout the lowlands of northern South America.

PREVOSTEA FERRUGINEA Choisy. River banks and flood sands at Muyrapenima on the Rio Negro, northern Brazil, *60;* at Manáos, *23;* known only from the Rio Negro and the upper Amazon.

CUSCUTACEAE

A sterile, unidentifiable species of *Cuscuta* was collected on dry parts of the Grand Savanna at Esmeralda, *314*.

VERBENACEAE[1]

Lowland species

Aegiphila Surfaceana Moldenke, sp. nov. Frutex; hornotinis crassiusculis densissime puberulentibus vel pubescentibus; foliis ternatis vel decussato-oppositis petiolatis; petiolis dense puberulentibus vel pubescentibus; laminis late oblongis vel interdum obovato-ellipticis plerumque in siccitate conspicue undatis, ad apicem abruptissime in cuspem angustatis, integris, ad basin acutis vel acuminatis, supra pubescentibus vel dense puberulentibus, subtus densissime pubescentibus; inflorescentiis axillaribus terminalibusque; cymis multifloris densis longe pedunculatis; paniculis terminalibus pyramidatis bracteatis; bracteis magnis et foliaceis aliquantum conspicuis et longe persistentibus in forma variabilissimis saepe inaequaliter geminatis; bracteolis linearibus pubescentibus; floribus pedicellatis; pedunculis pedicellisque gracilibus dense puberulentibus vel pubescentibus; calyce cupuliforme dense pubescente, limbo subtruncato vel breviter apiculato; corolla infundibuliforme, tubo cylindrico glabrato vel leviter piloso, limbo 4-partito, lobis ovatis rotundatis; staminibus 4 inclusis vel longe exsertis; filamentis glabris; pistillo longe exserto vel breviore; stylo capillare glabro; stigmate bifido; ovario oblongo 4-lobato 4-loculare glabro.

Branchlets stout and elongate, conspicuously tetragonal or subterete, brown, very slightly flattened and ampliate at the nodes, very densely puberulent or pubescent; leaf-scars rather large and prominent; internodes elongate, 5.5–11 cm. long; leaves ternate (or decussate-opposite), petiolate; petioles rather slender, ampliate at the base, densely puberulent or pubescent; blades membranous, dark green above, light beneath, usually conspicuously undate in drying, broadly oblong, sometimes somewhat obovate-elliptic, 12–18 cm. long, 5–9.5 cm. wide, very abruptly narrowed at apex into a cusp about 8 mm. long or less, entire, acute or acuminate at base, pubescent above or becoming merely densely puberulent, very densely pubescent beneath; midrib often stout, very prominent and very densely brownish-pubescent beneath; secondaries slender, 5–8 pairs, ascending, very prominent and densely brown-pubescent beneath; inflorescence axillary and terminal; cymes axillary, many-flowered, dense, 5–10 cm. long, 4–6 cm. wide, solitary, opposite, long-pedunculate, bracteolate, in female-predominant plants irregularly brachiate with its branches more or less at right angles to the peduncle, in male-predominant plants beautifully dichotomously branched throughout, the uppermost gradually merging into the terminal panicle; panicle terminal, composed of several pairs of axillary cymes and one terminal one, to 15 cm. long and 6 cm. wide, pyramidal, bracteate; bracts large and foliaceous, usually quite conspicuous and persistent, similar to the leaves but smaller, to 6 cm. long and 3.5 cm. wide, very variable in size and shape, often unequally paired; bractlets linear,

[1] *Aegiphila* by H. N. Moldenke.

to 6 mm. long, pubescent; prophylla setaceous, 1.5–2 mm. long; flowers pedicellate; peduncles slender, 2.5–5.5 cm. long, densely puberulent or pubescent; pedicels slender, 4–5 mm. long, puberulent or pubescent; calyx cupuliform, about 2 mm. long and wide, densely pubescent without, glabrous within, its rim subtruncate or shortly apiculate; corolla infundibular, its tube cylindrical, about 5.2 mm. long, glabrate or sparsely pilose, its limb 4-parted, its lobes ovate, about 3.6 mm. long and 1.8 mm. wide, rounded; stamens 4, inserted about 1.8 mm. below the mouth of the corolla-tube, included in female, long-exserted in male; filaments filiform, 0.2–5.7 mm. long, glabrous; anthers oblong, about 0.7 mm. long and 0.5 mm. wide; pistil long-exserted in female, much shorter in male; style capillary, to 9.8 mm. long, glabrous; stigma bifid, its branches about 5.2 mm. long; ovary oblong, dark, about 1 mm. long and wide, 4-lobed at apex, 4-celled, glabrous; fruit not seen.

San Carlos, Rio Negro, northern Brazil, *162* (type). The type is male-predominant and is marked by being puberulent throughout, its leaves ternate, and its inflorescence conspicuously dichotomous throughout. This species, named in grateful appreciation for Dr. Harvey Adam Surface, distinguished naturalist, scientist, and educator, has likewise been collected in the State of Pará by Dahlgren and Sella (no. *173*) and Huber (no. *2022* and *3296*), and in British Guiana by Schomburgk (no. *981*). These other specimens are female-predominant, densely pubescent throughout, and have the inflorescence irregularly brachiate. More detailed discussion will be found in my forthcoming monograph of this genus.

AMASONIA PUNICEA Vahl. In forest at Santa Isabel, on the Rio Negro, northern Brazil, *81*, *88;* a small upright shrub in the forest at Foothills Camp near Esmeralda, 750 ft., *393*. The species is distributed throughout the lowlands of northern South America.

CLERODENDRON THOMPSONAE Balf. At Piedra Alta, on the Rio Negro, northern Brazil, *149;* an African species now widely cultivated throughout tropical America for its handsome flowers.

LIPPIA GEMINATA HBK. At Yucabí, on the Rio Negro, northern Brazil, *130;* widely distributed through tropical America.

Species of Mount Duida

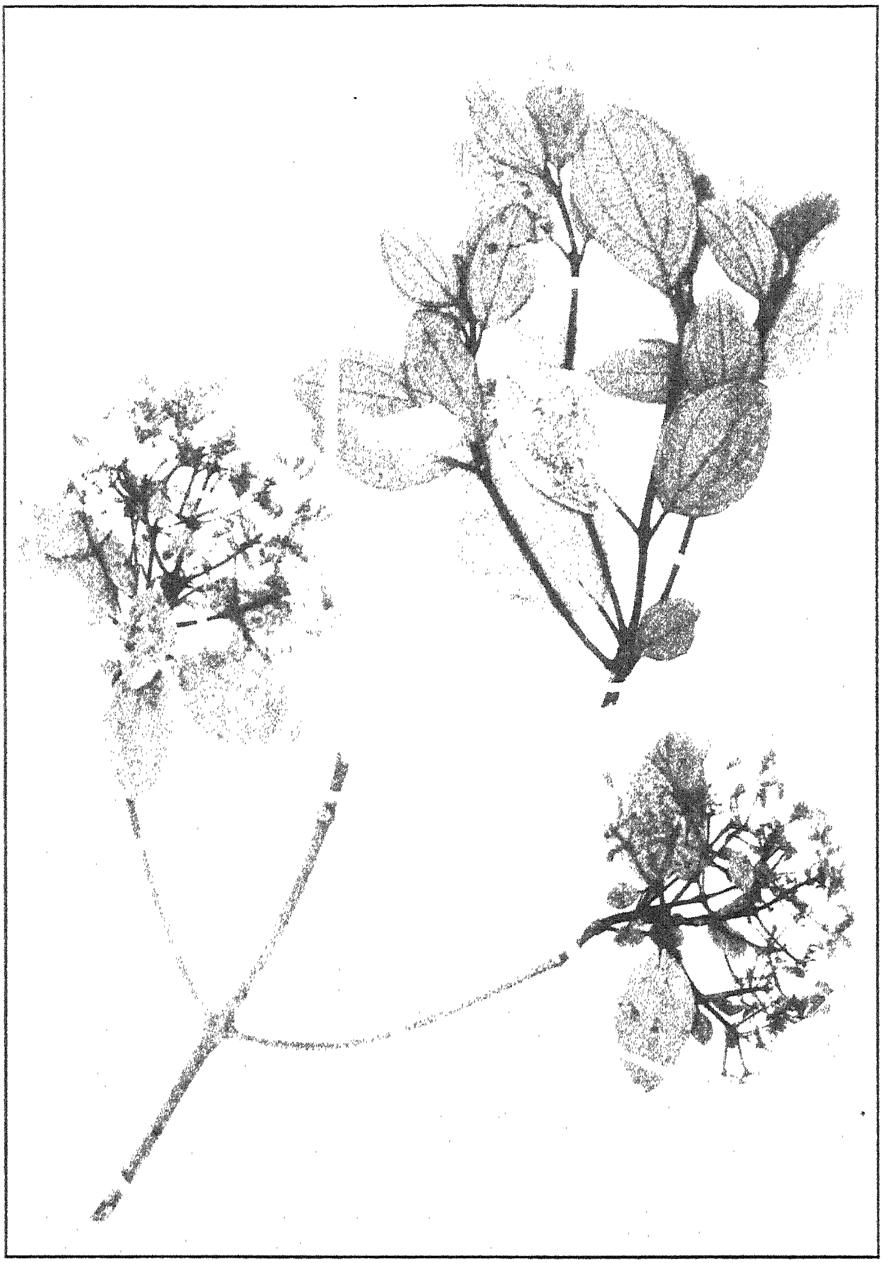
Amasonia obovata Gleason, sp. nov. Caule tenuiter anguloso breviter patenti-pubescente; petiolis brevibus canescentibus; foliis magnis membranaceis oblanceolatis subintegris acutis ex medio ad basin longe cuneatis supra et subtus ad venas minutissime puberulentibus; inflorescentia elongata erecta pubescente; bracteis subsessilibus late obovatis apice rotundatis irregulariter serrulatis utrinque puberulis; pedicellis brevibus pubescentibus; calyce late

campanulato tenuiter pubescente ad medium gamosepalo, lobis triangularibus e basi lata sensim acuminatis; bacca nigra.

Apparently erect and shrubby, the stem obscurely and irregularly but sharply angled, thinly pubescent with short spreading hairs; leaves crowded below the inflorescence; petiole 1 cm. long, thinly canescent; blades thin and membranous, bright green, oblong-oblanceolate, as much as 36 cm. long by 10 cm. wide, acute, cuneate from the middle to the base, essentially glabrous, but the upper surface and the veins beneath very minutely puberulent, secondary veins arcuately ascending, with the midvein and larger veinlets prominulous on both sides; inflorescence straight, erect, 25 cm. long, more densely pubescent than the stem, bearing numerous 1–3-flowered lateral cymes; bracts subsessile, broadly obovate, 3–1 cm. long, 20–8 mm. wide, broadly rounded above, cuneate at base, puberulent on both sides; pedicels about 6 mm. long, densely pubescent; calyx broadly campanulate, 8 mm. long, thinly puberulent, its lobes triangular from sharp acute sinuses, 5 mm. long, 2 mm. wide at base, acuminate to a subulate tip; corollas fallen; fruiting calyx considerably expanded, its lobes 6 mm. wide at base; fruit globose, black.

At Agüita, 3100 ft., *902*. *A. obovata* is distinguished at once from the other species of the genus by its broadly obovate bracts. In leaf-shape and general habit it closely resembles *A. punicea* Vahl of the Amazonian lowlands.

(*Concluded in the November Issue*)



TATEANTHUS DUIDAE × 1/2

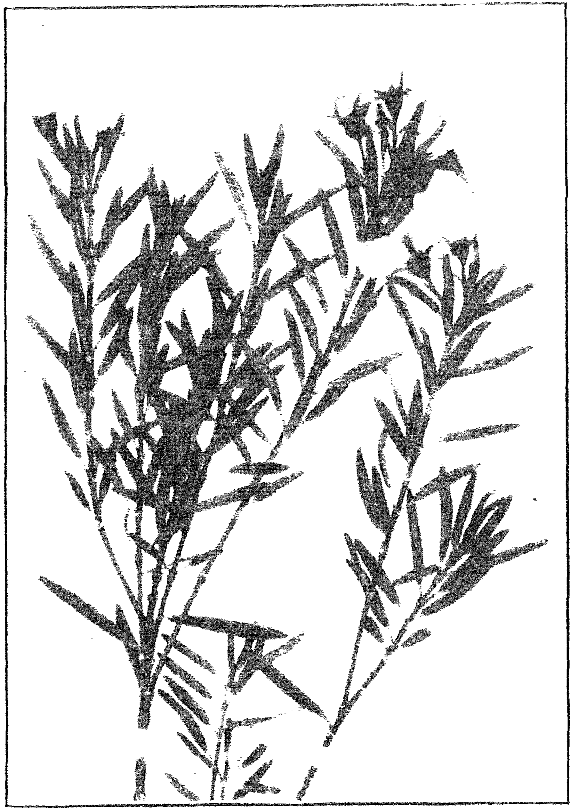
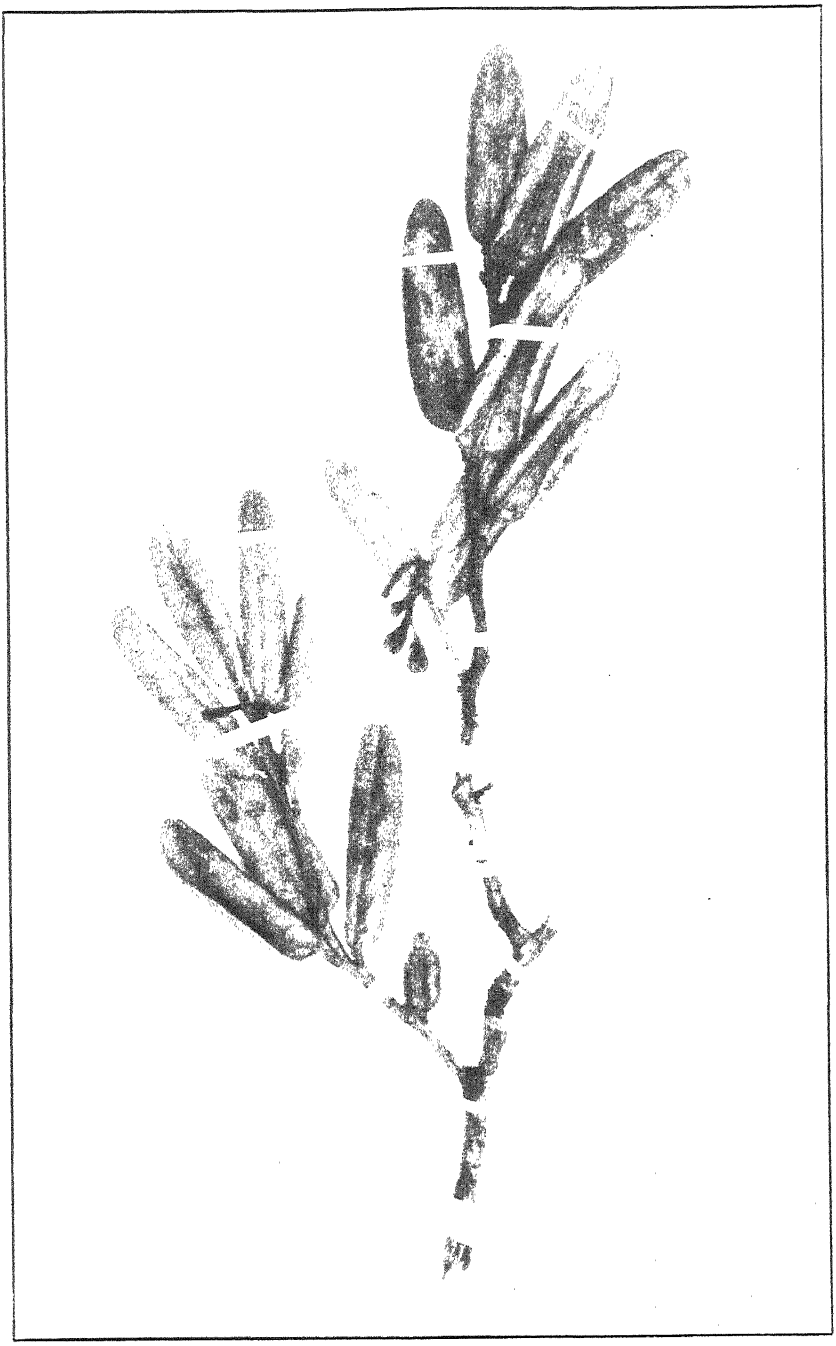
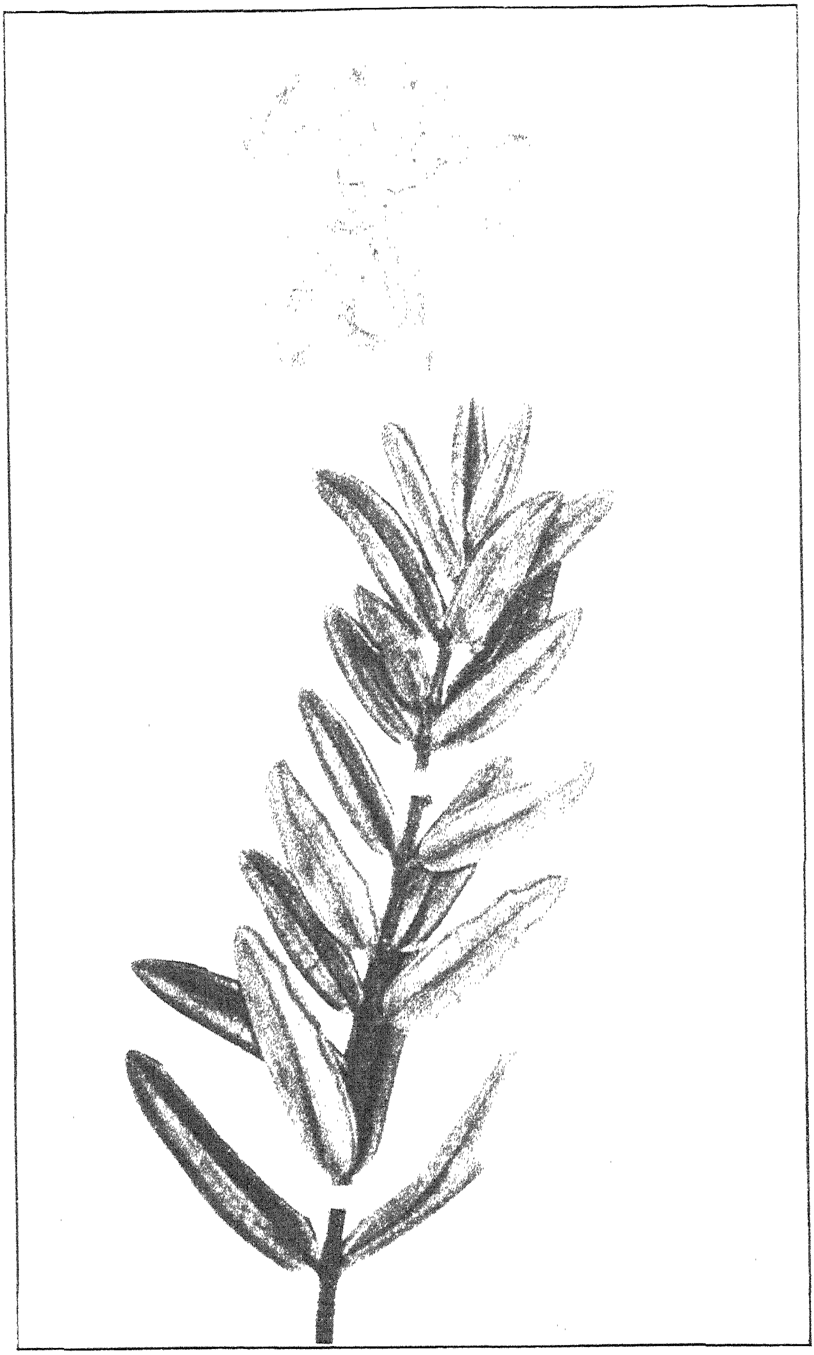


FIG 1. MACAIREA LINEARIS

FIG. 2. EPISCIA CORDATA



MYCERINUS SCLEROPHYLLUS × 1/2



SALPINCTES KALMIAEFOLIUS

Botanical results of the Tyler-Duida Expedition

H. A. GLEASON

(*Continued from the October issue*)

LABIATAE[1]

Lowland species

HYPTIS ATRORUBENS Poit. In second growth, Santa Isabel, northern Brazil, *84;* throughout the American tropics from Mexico and the West Indies to Peru and Brazil.

HYPTIS PARKERI Benth. East swamp at Esmeralda, *255;* also known from British Guiana and Amazonian Brazil.

HYPTIS PARKERI Benth., var. **verbenaefolia** (Mart.) Epling, comb. nov. (*Hyptis verbenaefolia* Mart. Fl. Bras. 8^1: 110. 1858.)

River banks and flood sands, Muyrapenima, northern Brazil, *74;* British Guiana and Brazil.

HYPTIS RECURVATA Poit. In second growth, Santa Isabel, northern Brazil, *1060;* throughout the American tropics from Mexico and the West Indies to Bolivia and Brazil.

MARSYPIANTHES CHAMAEDRYS Briq. In second growth, Santa Isabel, northern Brazil, *92;* widely distributed throughout tropical America from Mexico and the West Indies to Bolivia and Paraguay.

SOLANACEAE[2]

Lowland species

SOLANUM UMBELLATUM Mill. In forest at Santa Isabel, northern Brazil, no. 87. I have seen no other specimens from South America, but its occurrence there is not surprising. I can not separate it from Central American plants of the same species.

Species of Mount Duida

CESTRUM TENUIFLORUM HBK., var. **glabrescens** Morton, var. nov. Arbuscula, ramis ramulisque teretibus glabris; foliis brevipetiolatis ellipticis utrinque acutis, glabris, venis lateralibus circa 5; inflorescentia axillare spicata, foliis fulcrantibus deciduis quam foliis minoribus; floribus sessilibus; calyce

[1] By Carl Epling.

[2] By Conrad V. Morton.

[THE BULLETIN FOR OCTOBER (58: 405–464) WAS ISSUED 22 DECEMBER 1931.]

dentato coriaceo glabro ciliolato; corollae tubo gracile utrinque glabro superne ampliato lobis subulatis intus tomentulosis marginibus incurvatis; filamentis glabris edentatis; antheris parvis; ovario glabro stipitato; baccis subglobosis papillosis; seminibus 3-angulatis.

A small tree, the branches and branchlets terete, glabrous; leaves petiolate (petiole 1–2 cm. long, glabrous), 6 by 2.5 cm. to 13 by 6 cm., acute at both ends, green and glabrous on both sides, secondary veins about 5; inflorescence of short axillary spikes, the subtending leaves reduced in size, deciduous in age; rachis glabrous or very minutely reddish-puberulent; pedicels obsolete; calyx 2 mm. long, shallowly 5-dentate, coriaceous, glabrous, ciliolate, in fruit shallowly and irregularly lobate, subtending about one fourth of the berry; corolla-tube white (Tate), 20 mm. long, 1 mm. wide at base, gradually wider above (2 mm. at throat), glabrous within and without, lobes 5, subulate, 3 mm. long, tomentulose within, the margins incurved; stamens 5; filaments glabrous, without teeth or appendages, adnate to the corolla-tube for 15 mm., the free portion 2–3 mm. long; anthers small, less than 0.5 mm. long; style slender, 17 mm. long, glabrous; stigma flattened; fruit subglobose, green (Tate), 6 mm. in diameter, papillose; seeds 3-angled, 3 mm. long.

At Agüita, 3100 ft., *885*. The typical form of the species, which is also from Mount Duida, is a shrub with the leaves tomentulose on the veins beneath, filaments slightly pilose at base, and stigma subcapitate. Schultz has reduced it to varietal rank under *C. latifolium*, but almost certainly incorrectly so.

Solanum sp. A species of the section *Leiodendron*, with lanceolate, long-acuminate leaves and green berries, was collected at Agüita, 4000 ft., *920*. It is not identifiable without flowers.

SCROPHULARIACEAE[1]

Lowland species

Naiadothrix reflexa (Benth.) Pennell. In the East Swamp at Esmeralda, *252;* also known from northern and central Brazil.

Buchnera palustris (Aubl.) Spreng. Unflooded grassy swamps at Esmeralda, *175;* chiefly on savannas, from the Guianas to Bolivia.

GESNERIACEAE

Species of Mount Duida

Episcia cordata Gleason, sp. nov. Caulibus subrepentibus parce pubescentibus; petiolis elongatis crassis densiuscule pilis articulatis pubescentibus; laminis oblongo-ellipticis obtusis vel subrotundatis crenatis basi cordatis

[1] By Francis W. Pennell.

utrinque pubescentibus; paniculis confertifloris dense pubescentibus; sepalis distinctis oblongo-lanceolatis 3-nerviis intus basi villosis extus inferne hirsutis superne subglabris, antico deflexo quam posticis 4 erectis angustiore; corolla pubescente tubulosa basi calcarata, calcare rotundato, tubo superne dilatato, limbo patulo lobis integris rotundatis; staminibus ad basin corollae insertis, filamentis elongatis curvatis, antheris in juga 2 approximatis, thecis ovatis apice confluentibus; disco triangulare dorsale; ovario villoso libero.

Stems herbaceous and spreading, apparently pubescent chiefly near the nodes; petioles stout, at maturity as much as 8.5 cm. long, freely pubescent, especially on the dorsal side, with crooked jointed hairs 1–1.5 mm. long; blades firm, dark green, oblong-elliptic, as much as 13 cm. long by 5.5 cm. wide, obtuse or subrotund at summit, conspicuously crenate and ciliate with hairs like those of the petioles, cordate at base, scabrously pubescent above, the crooked hairs tending to be aggregated in the center of the vein-areoles, sparsely pubescent on the veins beneath; veins obscure above, plane but conspicuously reticulate beneath, the laterals 10–15 mm. apart and arcuately ascending; inflorescence a short, crowded but few-flowered, terminal or subterminal panicle, sessile or nearly so; pedicels short, densely hirsute with hairs like those of the petiole; sepals 5, separate to the base, lance-oblong, 3-nerved, reticulately veined, sparsely villous within near the base, densely hirsute without in the basal half with spreading hairs 1.5 mm. long, the distal half nearly glabrous, the posterior 4 erect, 9 mm. long, nearly 3 mm. wide, with about 2 teeth on each side near the apex, the anterior one strongly deflexed behind the corolla-spur, 7.5 mm. long, nearly 2 mm. wide, sharply dentate near the apex; corolla tubular, 6 cm. long; basal spur anterior, rounded, 4 mm. in diameter and length, villous; tube 3.2 mm. in diameter at base, gradually dilated upward and 8 mm. in diameter at the throat, villous throughout; limb spreading, about 2 cm. wide, its lobes broadly rounded, entire, delicately and remotely reticulate; stamens 4, attached just above the base of the corolla; filaments 1 mm. wide at the flat base, adnate to the corolla for 2 mm., the free portion 23 or 27 mm. long, outwardly curved above the middle and then inwardly curved, bringing the anthers together in 2 pairs; anthers 2-celled, broad, the thecae divergent at base, confluent at the apex; disk fleshy, truncate-triangular, 1.7 mm. long, on the dorsal side of the ovary; ovary wholly superior, ovoid, flattened laterally, 3.5 mm. long, densely villous with ascending hairs 1–1.5 mm. long; style filiform, 21 mm. long, minutely sericeous; stigma somewhat cyathiform, nearly 2 mm. in diameter (Pl. 35, fig. 2).

Waterfall at Agüita, 3100 ft., *878;* spreading over rocks, the leaves variegated, the flowers mauve. Its nearest relative appears to be *E. hirsuta* Benth.

Episcia cuneata Gleason, sp. nov. Caulibus diffusis prostratis forsan repentibus; petiolis elongatis parce pubescentibus; laminis membranaceis oblongo-lanceolatis acuminatis argute serratis et minute ciliatis basi longe cuneatis et

ad petiolum decurrentibus subtus ad venam mediam parce pilosis ceterum glabris, venis supra planis subtus leviter elevatis, lateralibus arcuatim adscendentibus; paniculis basalibus longipedunculatis, pedicellis gracilibus; sepalis suberectis lanceolatis acuminatis glabris; corolla tubulosa parva glabra basi saccata, limbi patuli lobis ovato-oblongis rotundatis; filamentis inclusis superne curvatis; antheris ovatis in juga conniventibus; disco carnoso dorsale; ovario glabro ellipsoideo, stylo crasso curvato, stigmate obliquo.

Stems spreading and possibly creeping, the leaves crowded at the end; petioles elongate, as much as 10 cm. long and always nearly equaling the blades, thinly pubescent with jointed hairs, glabrescent with age; blades thin, dark green, oblong-lanceolate, as much as 18 cm. long by 4 cm. wide, long-acuminate, sharply and deeply serrate, minutely ciliate, long-cuneate at base and more or less decurrent on the petiole, minutely and sparsely appressed-pilose on the midvein beneath, otherwise glabrous; veins plane and obscure above, lightly elevated beneath, the laterals about 1 cm. apart, curved-ascending; panicles numerous, on nearly glabrous, slender peduncles 5–10 cm. long, becoming thinly pilose in the branches; pedicels very slender, 10–15 mm. long; sepals thin and herbaceous, erect or somewhat spreading, lanceolate, 4 mm. long, 1 mm. wide, long-acuminate, somewhat recurved at the tip where they are slightly carinate, glabrous; corolla 10 mm. long over all, glabrous, merely saccate at base, where it is 2.7 mm. in diameter, the tube slender, not expanded upward, the limb 7 mm. wide, the lobes broadly ovate-oblong, 3 mm. long; stamens 4, included; filaments adnate to the corolla for 1.5 mm; curved above into a half-circle, bringing the ovate anthers together in pairs; disk a thick and fleshy, lingulate, brown gland on the dorsal side of the ovary, 1.2 mm. long, and 4 nearly terete, separate glands 0.6 mm. long, on the ventral side.

Waterfall at Agüita, 3100 ft., *879*, described by the collector as a spreading herb with smooth green leaves and white flowers. I know of no named species of *Episcia* with which ours may be compared. Its leaf-form is similar to that of *Schomburgk 3379*, from British Guiana, with hairy leaves, and *Altson 372*, from the same country, with hairy leaves decurrent to the base of the petiole.

LENTIBULARIACEAE[1]

Lowland species

ARANELLA FIMBRIATA (HBK.) Barnh. East Swamp, Esmeralda, *270;* widely distributed from Florida to eastern Central America and Paraguay.

Calpidisca amethystina (St.-Hil. & Girard) Barnh., comb. nov. *Utricularia amethystina* St.-Hil. & Girard, Ann. Sci. Nat. Bot. II. **11**: 162. 1839.

[1] By John Hendley Barnhart.

East Swamp, Esmeralda, *269;* Lesser Antilles and Venezuela to Uruguay.

Calpidisca hispida (Lam.) Barnh., comb. nov. *Utricularia hispida* Lam. Tab. Encyc. **1**: 50. 1791.

East swamp, Esmeralda, *267;* Trinidad to Venezuela and Brazil.

SETISCAPELLA PUSILLA (Vahl) Barnh. East Swamp, Esmeralda, *271;* West Indies and Mexico to Colombia and Paraguay.

Species of Mount Duida

GENLISEA RORAIMENSIS N. E. Brown. Slopes of Ridge 25, 5500–6000 ft., *442;* Central Camp, 4800 ft., *1020;* otherwise known only from the summit of Mount Roraima.

ORCHYLLIUM ALPINUM (Jacq.) Barnh. Valley Head, 5000 ft., *699;* on mountain summits, Lesser Antilles to Venezuela.

Orchyllium Schimperi (Schenk) Barnh., comb. nov. *Utricularia Schimperi* Schenk, Jahrb. Wiss. Bot. **18**: 230. 1887.

Savanna Hills, 4400 ft., *826;* epiphytic; from the Lesser Antilles through northern South America to Central America.

ORCHYLLIUM CAMPBELLIANUM (Oliver) Gleason. Slopes of Ridge 25, 5500–6000 ft., *432;* Peak 7, 6900 ft., *673;* epiphytic on mossy tree-trunks; otherwise known only from the upper slopes of Mount Roraima.

Orchyllium Humboldtii (Schomb.) Barnh., comb. nov. *Utricularia Humboldtii* Schomb. Verh. Beförd. Gartenb. Preuss. **15**: 141. 1840.

Crest of Ridge 25, 6300 ft., *408;* summit of Peak 7, 7100 ft., *637;* without locality, *1011;* Ridge 16, *1012;* all growing in leaf-bases of bromeliads except *1011*, which grew in the soil; otherwise known only from the vicinity of Mount Roraima and its slopes.

Calpidisca modesta (A. DC.) Barnh., comb. nov. *Utricularia modesta* A. DC. Prodr. **8**: 17. 1844.

Ridge 24, 5600 ft., *477;* Central Camp, 4800 ft., *549;* Colombia and Venezuela to Bolivia.

SETISCAPELLA SUBULATA (L.) Barnh. Central Camp, 4800 ft., *547;* widely distributed in eastern North America, the West Indies, and northern and eastern South America.

ACANTHACEAE[1]

Lowland species

MENDONCIA SPRUCEI Lindau. New growth in burned forest at Middle Camp, Esmeralda, *342;* also in northwestern Brazil.

[1] By E. C. Leonard.

RUBIACEAE[1]

Lowland species

LADENBERGIA LAMBERTIANA (Mart.) Klotzsch. Rocky top of Esmeralda Ridge, *206*. A small tree, occurring in the upper Amazonian region of Brazil, and in southern Venezuela.

REMIJIA HISPIDA Spruce. Rocky top of Esmeralda Ridge, *214;* among bushes at base of Esmeralda Ridge, *277*. A shrub; known only from this locality, the type having been collected here by Spruce.

SIPANEA GLOMERATA HBK. In second growth, Santa Isabel, Rio Negro, *98*. Venezuela and northern Brazil; an erect herb, sometimes woody at the base with densely clustered, yellow flowers about 2 cm. long; fruit capsular.

SABICEA AMAZONENSIS Wernham. Yucabí, on the Rio Negro, *128*. Occurring in northern Brazil and southern Venezuela. A stout woody vine, the leaves densely felted beneath.

ALIBERTIA BERTIERIFOLIA Schum. River banks and flood sands, Muyrapenima, *67*. The type material of this shrub was collected at Manáos, Brazil.

RETINIPHYLLUM SCHOMBURGKII (Benth.) Muell.-Arg. Tree Savanna, Esmeralda, *321*. Also in British Guiana, Surinam, and Brazil. The species is reported from Roraima, but the altitude at which it occurs there is not recorded. Tate describes the plant as a shrub with white flowers and translucent red fruit.

Ixora duidae Standl., Field Mus. Pub. Bot. **7**: 412. 1931. A tree, glabrous throughout, the branchlets slender, olivaceous, somewhat compressed, the internodes elongate; stipules erect, subpersistent, lance-linear, striate; leaves thick-membranaceous, short-petioled, the blades oblong or elliptic-oblong, acuminate, acute at the base; inflorescences axillary, cymose-paniculate, very lax, many-flowered, the very slender peduncles 5—11 cm. long; flowers sessile or on pedicels 2 mm. long or less; calyx obtusely dentate; corolla small, hypocrateriform, the lobes broadly oblong, obtuse, less than half as long as the tube.

Hillside at Foothills Camp, 750 ft., *392*. The leaves suggest those of the Brazilian *Ixora membranacea* Muell.-Arg., but that has a quite different, terminal inflorescence. Very few species of *Ixora* with axillary inflorescence

[1] By Paul C. Standley. The Duida collections contain two genera and twenty-two species considered to be new to science. In order to avoid delay in the printing of his studies on the Rubiaceae of Venezuela, Mr. Standley has published these new genera and species elsewhere and only abbreviated descriptions are given here.

are known, and this plant does not seem to be closely related to any of the American ones.

FARAMEA ANGUSTIFOLIA Benth. & Hook. A shrub in forest, San Gabriel, Rio Negro, *136*. The species is known only from this general region of northern Brazil.

CEPHAELIS BARCELLANA (Muell.-Arg.) Standl. Middle Camp, Esmeralda, *371;* Santa Isabel, on the Rio Negro, in forest, *89*. Also in the Amazon Valley of Brazil and Peru, and occurring on Mount Duida. A shrub with large red bracts, dense heads of small yellow flowers, and blue fruits. This species is closely related to *C. tomentosa* (Aubl.) Vahl. In that the pubescence of the leaves consists of widely spreading hairs, while in *C. barcellana* the hairs along the costa and veins are rather closely appressed.

GEOPHILA HERBACEA (Jacq.) Schum. Foothills Camp, 750 ft., *395*. A slender creeping herb with long-petioled heart-shaped leaves; flowers small and white; fruits red, juicy, usually black at maturity. The plant is generally distributed in the lowlands of tropical America, often as a weed in cultivated ground, especially in banana plantations.

GEOPHILA TRICHOGYNE (Muell.-Arg.) Standl. Middle Camp, Esmeralda, *1006*. A slender creeping herb with long-petioled heart-shaped acute leaves, the small flowers in stalked headlike inflorescences. Ranging widely in the Amazon Valley of Brazil and Peru.

PSYCHOTRIA PATENS Sw. Caxoeira San Sebastián, Rio Casiquiare, *150*. A slender shrub with narrow thyrsiform inflorescence, one of the widely distributed species of tropical America.

PSYCHOTRIA INVOLUCRATA Sw. Middle Camp, Esmeralda, *374*. One of the widely distributed species of tropical America. A shrub with purplish black fruits.

PSYCHOTRIA RACEMOSA (Aubl.) Willd. In forest at Foothills Camp, Esmeralda, 750 ft., *396;* San Gabriel, on the Rio Negro, *139*. A shrub with black fruit. From most of the species of *Psychotria* this is easily distinguishable by its normally 5-celled fruit, that of other species being 2-carpellate. The species is one of those most widely distributed in the American tropics.

PSYCHOTRIA RHODOTHAMNA Standl. Middle Camp, Esmeralda, *948*, *955*. Occurring also in the Amazon Valley of Peru. A shrub or small tree with white flowers.

PSYCHOTRIA SANTAREMICA Muell.-Arg. Middle Camp, Esmeralda, *373*. Widely dispersed in the Amazon Valley of Brazil and Peru and in Colombia. A shrub with white fruits.

PSYCHOTRIA BRACTEATA DC. Caxoeira San Sebastián, Rio Casiquiare, *151*. Ranging through French and British Guiana, and in northern Brazil. A shrub, the inflorescence with numerous linear bracts.

PSYCHOTRIA RHODOLEUCA Muell.-Arg. In forest, Santa Isabel, Rio Negro, *94*. A shrub, very similar to the last preceding species. The type was collected at San Carlos on the Rio Negro.

PSYCHOTRIA LUPULINA Benth. Left bank of the Rio Casiquiare at Quemapure, *167*. The species ranges from the Guianas to Brazil, Bolivia, and Colombia. It is a shrub with small inflorescences subtended by broad bracts.

PALICOUREA LONGIFLORA DC. Santa Isabel, Rio Negro, *985*. Apparently a slender shrub. Known also from the Guianas.

PALICOUREA TRIPHYLLA DC. Middle Camp, Esmeralda, *956*; Santa Isabel, Rio Negro, *85*. Ranging from Bolivia to the Guianas, Trinidad, and Central America. A shrub with ternate leaves, the flowers in narrow thyrsoid panicles; peduncles orange; corolla yellow.

PAGAMEA CORIACEA Benth. Rocky top of Esmeralda Ridge, *196;* Foothills Savanna at Esmeralda, *943*. The species is known only from Esmeralda.

PERAMA GALIOIDES Poir. Grand Savanna, Esmeralda, *290;* East swamp, Esmeralda, *266;* in open savanna, Esmeralda, *180*. A low slender herb with narrow leaves and short headlike flower spikes; flowers yellow. The species is known only from southern Venezuela and northern Brazil.

DIODIA HYSSOPIFOLIA (Willd.) Cham. & Schlecht. Yucabí, Rio Negro, *976*. A weedy species, widely distributed in Brazil, the Guianas, and Colombia.

BORRERIA ALATA (Aubl.) DC. Muyrapenima, Rio Negro, on river banks and flood sands, *54*. Occurring in the Guianas and northern Brazil.

BORRERIA LATIFOLIA (Aubl.) Schum. Santa Isabel, Rio Negro, in sandy soil in open ground, *78*. Widely distributed in tropical America; a common weed in many regions.

An unidentified sterile specimen from woods at Foothills Camp, *385*, is probably a species of *Anisomeris*.

Species of Mount Duida

REMIJIA TENUIFLORA Benth. At Agüita, 3100 ft., *930*. A small tree. Occurring also in British Guiana and along the Rio Negro in Brazil. Although the Mount Duida specimen is noteworthy for its large and many-flowered inflorescences, and for the large leaves with almost perpendicular

veins, probably it is no more than a form of *R. tenuiflora*, and I see no easy means of distinguishing it specifically.

Remijia laevifolia Standl., *op. cit.* 359. A large shrub, the young branches stout, glabrous, the internodes 1–1.5 cm. long; stipules caducous, about 2.5 cm. long, acute, sparsely strigose; leaves coriaceous, very shortly petioled, the blades oblong or narrowly elliptic-oblong, acuminate, at the base acute, glabrous; inflorescences axillary, cymose-corymbose, long-peduncled, very dense and many-flowered; flowers sessile; calyx 5-lobate to below the middle, the segments narrowly lance-triangular, long-acuminate, capsule elliptic-oblong, 7–10 mm. long, rather densely appressed-pilosulous.

Dry ridge-tops, Savanna Hills, 4400 ft., *802*. The plant represented by the type specimen evidently is closely related to *R. tenuiflora* Benth., but it seems to be fairly distinct, although ampler material may show that it can not be maintained as a separate species. *R. tenuiflora*, according to type and other material, differs in having much longer petioles, less strongly coriaceous leaves, a much laxer inflorescence, and more slender capsules.

Ladenbergia lucens Standl., *op. cit.* 362. A straggling tree, completely glabrous except possibly on the corollas (corollas not seen); stipules caducous, lance-oblong, acuminate; leaves petiolate, thick-coriaceous, the blades oblong-elliptic to elliptic-ovate, slightly narrowed toward the rounded or very obtuse apex, at the base broadly rounded, bright green and very lustrous on the upper surface, beneath much paler; inflorescence terminal, laxly cymose-paniculate, few-flowered, on a stout peduncle 2–4 cm. long, the flowers chiefly on short stout pedicels; calyx deeply 5-fid, the segments triangular, acuminate.

Bank of a stream at Central Camp, 4800 ft., *558*. The material upon which this description is based is incomplete and far from satisfactory for study, but it seems to represent a species unlike any illustrated in the large series of the genus found in the herbarium of the Field Museum. Since it is improbable that the plant will be re-collected soon, it is perhaps best to give it a name, although the writer realizes that already too many species have been proposed in *Ladenbergia*.

Hillia parasitica Jacq. Desfiladero, 6000 ft., *710*. A straggling bush with slender branches and thick leaves; flowers white, with a long slender tube. Widely distributed in tropical America. The plant usually is epiphytic, and the branches sometimes are more or less scandent.

Chalepophyllum Tatei Standl., *op. cit.* 379. A shrub, the branches stout, the older ones covered by the persistent stipules; stipules connate halfway to the base, densely whitish-strigose; leaves almost sessile, the blades thick-coriaceous, elliptic-oblong, 12–27 mm. long, acute, glabrous; flowers axillary, solitary, on short pedicels as much as 4 mm. long; hypanthium

densely white-hispidulous; calyx-lobes lance-linear, subequal, erect, sparsely hispidulous; corolla-tube 6.5–11 cm. long, its lobes 1.5–3 cm. long.

Summit of Peak 7, 7100 ft., *623* (type); slopes of Ridge 25, 5500–6000 ft., *427*; without data, *1016*. Of the genus *Chalepophyllum* two species have been published heretofore, the type, *C. guyanense* Hook. f., described from some uncertain locality of British Guiana, and *C. speciosum* N. E. Brown, obtained on Mount Roraima at an elevation of 2680 m. The original illustration of the type shows a plant with comparatively small flowers, and altogether different in general appearance from *C. Tatei*. The latter, however, is evidently closely related to *C. speciosum*, that species differing from *C. Tatei* in its more or less obovate, obtuse leaves and glabrous stipules. There is no doubt that *C. Tatei* is congeneric with *C. speciosum*, but there is considerable doubt in the writer's mind regarding their relationship with *C. guyanense*. Their status can not be resolved, however, without access to material of *C. guyanense*, and perhaps to better material than is afforded by the type specimen.

Chalepophyllum latifolium Standl., *op. cit.* 379. A shrub, with densely leafy branchlets and glabrous internodes; stipules connate into a glabrous sheath 2–2.5 mm. long, the free portion triangular-subulate, densely white-hispidulous near the base; leaves sessile, thick-coriaceous, oval, broadly rounded to obtuse at the apex, rounded at the base, glabrous; flowers axillary, solitary, on stout pedicels 2–3 mm. long; hypanthium densely hispidulous; calyx 5-parted, the segments linear-lanceolate, slightly unequal, ciliate but otherwise glabrous; corolla-tube 4–9 cm. long, the lobes oblong or elliptic-oblong, 1.5–3 cm. long; capsule globose or oval-globose, densely hispidulous.

On moist slopes of Savanna Hills, 4400 ft., *730*. It may be that this plant is only a variant of *C. Tatei* Standl., but it differs so much in the size and shape of the leaves and in the form of the stipules that it seems fairly safe to describe it as distinct. Both these species must be handsome plants, because of their profusion of large flowers, which presumably are white, although the collectors of the various species of the genus have vouchsafed no information upon flower color. In all the three species described since the original one, the size of the corolla seems to be exceptionally variable for members of the Rubiaceae.

Gleasonia Standl., op. cit. 372

Trees, the branchlets thick and hirsute. Stipules intrapetiolar, large, persistent, deeply bilobed. Leaves opposite, short-petioled, thick-coriaceous, oblong or elliptic-oblong. Flowers large, rose-color, bracteolate, sessile or pedicellate in many-flowered, terminal, pedunculate cymes. Hypanthium hemispheric, densely hirsute. Calyx 5-parted, the lobes large, subequal, elongate,

ligulate-spatulate, colored, rounded at apex. Corolla infundibuliform, densely hirsute and tomentose externally, the tube straight, densely pilose within, the lobes 5, imbricate, broadly ovate, obtuse, densely pilose within. Stamens 5, inserted at the base of the throat, subequal, included, the filaments very short, glabrous, the anthers linear, obtuse, dorsifix. Disc depressed-annular. Ovary 2-celled. Style thick, appressed-pilose, the two branches oblong, obtuse. Ovules numerous, densely crowded. Fruit not seen, apparently capsular.

Gleasonia duidana Standl., *op. cit.* 372. Branchlets subterete, stipules ferruginous, densely appressed-hirsute; leaves 14.5–21 cm. long, rounded or obtuse at the apex and short-apiculate, obtuse or acutish at the base, glabrous above, beneath hispidulous and along the costa appressed-hirsute; cymes repeatedly branched, the branches densely fulvous-hirsute, the bracts linear to ovate-lanceolate, hirsute or hispidulous (Pl. 39, fig. 2).

The Valley, 5000 ft., *467* (type); Central Camp, 4800 ft., *1026*. When growing this must be an exceedingly showy and handsome plant. The form of the calyx-lobes and the general appearance of the inflorescence is strongly suggestive of the genus *Triplaris* Loefl., which contains some of the most gorgeous of tropical American trees.[1]

Because of the absence of fruit and the uncertainty whether the seeds are winged or not, there is some question as to the tribal position of the tree, but it is probable that it is referable to the *Rondeletieae*, and allied with *Pallasia* Klotzsch and *Pteridocalyx* Wernh., both of which are natives of British Guiana. However, it is conspicuously distinct from both these two genera, in which only one or two of the calyx-lobes are enlarged and colored. In *Gleasonia* all the calyx-lobes are about equally developed, and all are brightly colored. Such a calyx is not found in any other American representative of the family Rubiaceae.

Retiniphyllum erythranthum Standl., *op. cit.* 399. A shrub, apparently densely branched, the young branches rather densely rough-puberulent; stipules 2–3 mm. long; leaves petiolate, the blades coriaceous, oval to broadly elliptic or oblong-elliptic, rarely oblanceolate-oblong, usually rounded or obtuse at the base, at the apex rounded or very obtuse and shortly apiculate, glabrous and shining on the upper surface, beneath paler, strigose along the costa, elsewhere glabrous; flowers terminal, few, clustered in a headlike inflorescence, closely sessile; involucel saucer-shaped, nearly entire; calyx shallowly dentate; corolla red, thinly sericeous outside, the lobes oblong, obtuse or acutish, reflexed; stamens exserted; pyrenes shallowly sulcate and obtusely costate dorsally.

[1] Large cream-colored inflorescences of this handsome tree were generally scattered through the *Tyleria* forest of Central Camp near the stream. The tree extended well toward Valley Head Camp and was also seen in one or two of the valleys along the southwest trail.—G.H.H.T.

Slopes at Central Camp, 4800 ft., *561* (type); summit of Ridge 25, 6000 ft., *465;* dry slopes of Savanna Hills, 4400 ft., *756*. The collector describes the plant as a "spindly shrub" with hard leaves and red calyx and corolla.

The genus *Retiniphyllum* is a rather isolated one in the Rubiaceae, being referred usually to a separate tribe, and being confined in its distribution chiefly to the Amazon Valley. The present species is referable to the subgenus *Commianthus* Muell.-Arg., in which it is noteworthy for its sessile headlike inflorescence.

Duidania Standl., *op. cit.* 408

Shrubs or trees, the branchlets thick, subterete or angular, glabrous, with elongate internodes. Stipules persistent, erect, short, connate, intrapetiolar, abruptly acuminate-apiculate. Leaves thick-coriaceous, short-petioled, opposite, the blades broadly oval or rounded, broadly rounded and apiculate at the apex. Flowers medium-sized, cymose-corymbose, the inflorescences terminal, sessile, very densely many-flowered, the flowers densely crowded, sessile or very shortly pedicelled, the bracts often foliaceous. Hypanthium small, obovoid. Calyx 5-parted, the lobes elongate, linear-filiform. Corolla hypocrateriform, puberulent or hispidulous, in the bud obtuse, the tube slender, smooth within, the 5 lobes valvate, narrowly oblong, attenuate, obtuse. Stamens 5, inserted on the throat of the corolla; filaments very short; anthers linear, dorsifix acute, subexserted. Disc depressed. Style filiform, glabrous, the 2 branches very short. Ovary 2-celled, the loculi 1-ovuled, the ovule attached to the middle of the septum. Capsule small, globose, coriaceous, terete, densely puberulent, septicidally 2-valved, 2-seeded. Seeds hemispherical, smooth.

Duidania montana Standl., *op. cit.* 409. Leaves more or less rugose, rounded or obtuse at the base, glabrous above, beneath paler, densely and minutely ochraceous-tomentulose, the margin often subrevolute; hypanthium densely ochraceous-puberulent; calyx-segments erect, hispidulous or puberulent (Pl. 38).

Slopes of Ridge 25, 5500–6000 ft., *420*. Although it is represented by complete and fairly ample material, the tribal position of this plant is not altogether clear, especially because of the unusual structure of the fruit. There are very few Rubiaceae that have capsular fruit with a single seed in each cell. The only American genus that seems to be related is *Ceratopyxis* Hook.f., a shrub native in Cuba. That is referred to the *Chiococceae*, where, however, it is anomalous because of its dry fruit, that of most members of the tribe being fleshy. *Ceratopyxis* differs conspicuously from the Mount Duida plant in its compressed capsules and in having the stamens inserted at the base of the corolla-tube, nor is it very similar in general appearance.

The peculiar appressed minute pale tomentum found on the under surface of the leaves of *Duidania* is not a common type of pubescence in the family, being found chiefly in the genus *Guettarda*, to which I do not believe that *Duidania* is closely related.

Pagamea montana Gl. & Standl., *op. cit.* 421. A shrub or small tree, glabrous except for the corollas, the internodes very short; stipules connate into a sheath 7–9 mm. long and bearing at the apex 8 slender teeth; leaves short-petiolate, the blades thick-coriaceous, oblong or narrowly elliptic-oblong, acute, gradually attenuate to the base; peduncles terminal and produced from the upper leaf-axils, 1–2.5 cm. long, the numerous sessile, 4–5-parted flowers crowded in a dense headlike cluster, calyx shallowly dentate, the teeth broadly triangular, acutish; corolla-lobes lanceolate, twice as long as the tube, densely white-villous within.

Dry ridge tops, Savanna Hills, 4400 ft., *803* (type); Agüita, 3800 ft., *926*. This species is related to *P. coriacea* Benth., which grows in the lowlands of the same general region. The latter has obtuse leaves, ovate calyx-lobes, longer stipules, and branched peduncles.

Pagamea garryoides Standl., *op. cit.* 420. A low shrub, the branches subterete or tetragonal, almost hidden by the persistent stipules; stipules densely sericeous; leaves short-petiolate, coriaceous, the blades elliptic or less frequently oblong-elliptic, acute or subobtuse, at the base obtuse or acute, above lustrous, at least when young covered with subappressed white hairs, beneath paler, densely pilose with spreading or subappressed hairs; flowers crowded in dense, subglobose, many-flowered heads on elongate, simple or 3-branched peduncles which are terminal or from the upper axils; calyx-lobes narrowly oblong-triangular, minutely hirtellous, acute; corolla 5-fid, the lobes twice as long as the tube, minutely pilose outside, densely white-villous within.

Rocks above Caño Negro, Savanna Hills, 4200 ft., *819* (type); Brocchinia Hills, 4500 ft., *585;* slopes of Ridge 24, 5900 ft., *464*. In its copiously pubescent leaves this differs conspicuously from most species of the genus. According to the collector, the leaves when fresh are stiff and shining.

Pagamea conferta Standl., *op. cit.* 418. A low shrub, the older branches stout, with very short internodes; stipules connate into a truncate sheath bearing at the margin 4 or more subulate setae; leaves coriaceous, very shortly petiolate, the blades lance-oblong or narrowly lanceolate, very long and narrowly acuminate, short-pilose along the costa beneath; flowers subcapitate, the heads axillary, small, short-peduncled; calyx minutely pilose, its lobes narrowly oblong-triangular, attenuate, longer than the hypanthium.

Dry rocky slopes of the Savanna Hills, 4400 ft., *794*. This plant is closely related, uncomfortably so in fact, to *P. capitata* Benth., a common species of the lowlands of British Guiana. It seems reasonably distinct,

however, in its smaller and more densely pubescent leaves, borne on very short petioles, and also in its nearly sessile inflorescences, the peduncles in *P. capitata* being usually 1–3 cm. long.

CEPHAELIS BARCELLANA (Muell.-Arg.) Standl. Agüita, 4000 ft., *921*. Southern Venezuela, and along the Amazon in Brazil and Peru. A shrub with large dense flower-heads, subtended by two broad, bright red bracts. In the Mount Duida specimen the bracts have elongate green tips. I have seen similar specimens of this and the closely related *Cephaelis tomentosa* (Aubl.) Vahl, and am of the belief that they represent only a minor variation of the species, although it may be that they are of a greater significance.

PSYCHOTRIA HOFFMANNSEGGIANA (R. & S.) Muell.-Arg. Agüita, 3100 ft., *898*. A shrub with white flowers and purple fruit, occurring also in the Guianas and in the Amazon Valley of Brazil.

PSYCHOTRIA CRASSA Benth. Slopes of Ridge 25, 5500–6000 ft., *433;* summit of Peak 7, 7100 ft., *624*. Described as a small tree 6 m. high; flowers small and white, the fruit red, translucent. The description of the plant as a small tree may be incorrect, for usually this species is a small epiphytic shrub. It is sometimes difficult, however, to decide whether an epiphytic shrub really is such or whether it is a tree. This species occurs in British Guiana and Venezuela, and is known from the slopes of Roraima.

Psychotria durifolia Standl., *op. cit.* 444. A straggling shrub, glabrous throughout, the branches ferruginous and densely leafy; stipules short-connate, triangular, erect, persistent; leaves sessile, thick-coriaceous, broadly elliptic to rounded-ovate, broadly rounded to obtuse at the apex and with a short apiculation, at the base broadly rounded or truncate, the veins very oblique; inflorescences axillary, longer than the leaves, long-peduncled, cymose, densely rather few-flowered; flowers sessile; calyx deeply lobed, the lobes broadly triangular or oval-ovate, acute to rounded at the apex; corolla glabrous without, 5-fid almost to the middle, its lobes obtuse, fleshy, not barbate within.

Stream-side at Central Camp, 4800 ft., *556* (type); moist slopes of Savanna Hills, 4400 ft., *757*. The plant is one of striking appearance and puzzling affinities. Without fruit it is not at all certain that it is properly referable to the genus *Psychotria*, but it can not be referred to any other American group of the family. In its foliage it is somewhat suggestive of *Psychotria cordifolia* HBK., of Venezuela and British Guiana, but in that the inflorescence is terminal and thyrsoid. Axillary inflorescence is infrequent in the genus *Psychotria*, and I know of no species with such inflorescence which remotely resembles the present plant.

Psychotria vernicifolia Standl., *op. cit.* 462. Branches stout, fuscous or somewhat ferruginous, minutely puberulent, the internodes very short; stipules persistent, connate, bilobate to the middle, the lobes broadly rounded; leaves thick-coriaceous, short-petioled, the blades ovate or ovate-oblong, 3–5 cm. long, acuminate, rounded or obtuse at the base, glabrous; inflorescences terminal, sessile, 3-rayed, the rays hirtellous, each bearing a dense cyme of rather few sessile flowers, the bracts minute or obsolete; calyx shallowly dentate; corolla-tube slender, scarcely dilated above, densely and minutely puberulent outside.

Summit of Peak 7, 7100 ft., *628*. Related to *P. Everardii* Wernham, which was described from Roraima, the leaves of the two species being similar in size and shape. In *P. Everardii*, however, the inflorescence is pedunculate and the leaves have more numerous veins.

Psychotria coussareoides Standl., *op. cit.* 441. Glabrous except in the inflorescence, branchlets rather stout, grayish-ochraceous, subterete, the internodes short; stipules united into a persistent truncate sheath; leaves subcoriaceous, slender-petiolate, opposite or ternate, the blades oblanceolate-oblong or obovate-oblong, obtuse or acute, rather long-attenuate to the petiole, deep green and lustrous on the upper surface, much paler beneath; inflorescence terminal, long-pedunculate, cymose-paniculate, rather laxly many-flowered, the branches sparsely and minutely puberulent, the flowers sessile in small dense cymules, the bracts mostly small, triangular, acute; calyx shallowly and acutely dentate; corolla small, almost glabrous, the 5 lobes ovate, obtuse, slightly shorter than the thick tube.

Agüita, 4000 ft., *919*. A rather well-marked species, noteworthy for its chiefly ternate leaves, but uncertain relationship, as is so often the case with species of *Psychotria*.

Psychotria chondroloma Standl., *op. cit.* 440. A shrub, with rather slender, subterete, glabrous branches, the internodes elongate; stipules erect, persistent, connate, bilobed, the lobes short, triangular, acute; leaves thick-coriaceous, yellowish green, short-petiolate, opposite, the blades oblong-lanceolate, very long-acuminate, acute at the base, glabrous, with an indurate pale margin; inflorescence terminal, umbelliform, long-pedunculate, densely hirtellous, its rays rigid, spreading or ascending, bearing 1–3 dense headlike cymes; flowers numerous, sessile; bracts foliaceous, oblong or lanceolate, almost concealing the flowers; corolla funnelform, sparsely hirtellous outside.

Laterite Valley, Savanna Hills, 4400 ft., *726* (type); Agüita Slope, 3500 ft., *700*. Evidently a relative of *Psychotria transiens* Wernham, described from Mount Roraima, which has an inflorescence similar in structure but glabrous. The leaves of *P. transiens* are conspicuously different in form and venation from those of *P. chondroloma*.

Psychotria Tatei Standl., *op. cit.* 460. Shrub, the branches rather stout, subterete, olivaceous or fuscous, minutely puberulent, the internodes short or elongate; stipules persistent, connate, 2 mm. long, shallowly bilobate or subtruncate, the lobes obtuse; leaves thick-coriaceous, short-petiolate, the blades oval or ovate-oval, 3.5–6.5 cm. long, obtuse to broadly rounded at the apex and short-apiculate, yellowish green, glabrous above, beneath minutely pilose on the veins; inflorescence terminal, sessile, cymose-paniculate, laxly few-flowered, trichotomous from the base, the basal branches strongly reflexed, the flowers sessile, the bracts minute and inconspicuous; calyx-teeth broadly ovate, acute; corolla narrowly funnelform, densely puberulent outside, its lobes half as long as the tube.

Slopes at Central Camp, 4800 ft., *568* (type); *1039*. The second collection cited has smaller leaves than the type, but otherwise appears to be conspecific. The affinities of *Psychotria Tatei* are altogether uncertain, but it seems to be a well-marked species, notable for the reflexed lower branches of the inflorescence, and for the very thick and handsome leaves.

Psychotria phaneroneura Standl., *op. cit.* 455. Glabrous except in the inflorescence, the branches rather stout; stipules erect, persistent, connate, 2 mm. long, bilobate, the lobes broadly rounded; leaves thick-coriaceous, yellowish green, short-petiolate, the blades broadly oval or ovate-oval, 5–6 cm. long, acute to broadly rounded at the apex, broadly rounded at the base; inflorescence terminal, fastigiate-cymose, long-pedunculate, densely many-flowered, the branches minutely puberulent, the flowers closely sessile, the bracts inconspicuous, subulate; fruit 2-locular, very minutely puberulent, the pyrenes obtusely costate dorsally.

Dry laterite soil, Savanna Hills, 4400 ft., *789*. In foliage the present plant is almost exactly like *Psychotria Tatei* Standl., but the inflorescences of the two species are altogether different. It is rather probable that *P. phaneroneura* should be referred to *Palicourea* Aubl. rather than to *Psychotria*, but this can not be decided definitely until the flowers are available for study.

Psychotria duidana Standl., *op. cit.* 443. A shrub, glabrous throughout except on the stipules, the branches slender and fuscous; stipules persistent, united into a sheath 1–2 mm. long, the sheath more or less hirtellous, produced into 4 linear lobes; leaves short-petiolate, opposite, the blades subcoriaceous, ovate-oblong or narrowly ovate, long-acuminate, at the base obtuse or rounded; inflorescence terminal, long-pedunculate, cymose, naked and trichotomous at base, the primary branches 7 mm. long or less, the bracts ovate or lance-ovate, the inner somewhat shorter than the flowers; flowers sessile; calyx shallowly dentate, the teeth broadly triangular, acute; corolla glabrous outside, its tube 8–10 mm. long, more than twice as long as the lobes.

Desfiladero, 6000 ft., *713*. Related to *P. bracteata* DC., which differs conspicuously in its narrower bracts.

Psychotria campylopoda Standl., *op. cit.* 437. Shrub, the branches slender, subterete, fuscous or olivaceous, densely scaberulous-puberulent, the youngest somewhat angulate, the internodes short or elongate; stipules persistent, connate into a truncate sheath bearing at its apex 4 short subulate lobes; leaves small, coriaceous, short-petiolate, the blades elliptic-oblong or ovate-oblong, acute or acutish, acute at the base, minutely scaberulous on both surfaces or in age nearly glabrous; inflorescences terminal and from the upper axils, pedunculate, capitate, few-flowered, recurved, the outer bracts about 4, elliptic or oblong, apparently green; fruit bilocular, subglobose, minutely scaberulous.

Hillsides and flat ground at Central Camp, 4800 ft., *534* (type); slopes of Ridge 25, 5500–6000 ft., *412*. The leaves are much like those of *Psychotria oblita* Wernham, described from Roraima, but the Mount Duida plant belongs in Mueller's subgenus *Cephaelis*, group *Pseudocephaelidae*. It is described as a slender, straggling bush. The collector's notes state that the corolla-tube is yellowish white and the lobes purple, but I find no corollas on any of the specimens available for study.

Psychotria cacuminis Standl., *op. cit.* 436. Branchlets rather slender, subterete, ferruginous, glabrous, the youngest ones sparsely and minutely puberulent, the internodes elongate; stipules erect, persistent, connate, 2–4 mm. long, shallowly bilobate, the lobes broadly rounded; leaves coriaceous short-petiolate, opposite, the blades broadly ovate to oblong-ovate, long-acuminate, at the base rounded or obtuse, when young minutely puberulent along the veins on both sides and sometimes very minutely puberulent between them, or almost glabrous; inflorescence terminal, cymose-corymbose, rather densely few-flowered, long-pedunculate, the bracts obsolete, the flowers sessile or nearly so; calyx minutely and obtusely 5-toothed; corolla tubular-funnelform, densely furfuraceous-puberulent, in bud subtruncate at the apex, its lobes half as long as the tube.

Crest of Ridge 25, 6300 ft., *410*.

Psychotria ceratantha Standl., *op. cit.* 439. Shrub, the branches slender, fuscous, glabrous or the young ones obscurely puberulent, the internodes mostly elongate; stipules small, persistent, connate into a truncate sheath bearing at the apex 4 triangular obtuse lobes; leaves short-petiolate, thinly coriaceous, the blades oblong-elliptic or lance-oblong, 4–14 cm. long, long-acuminate, acute at the base, glabrous; inflorescence terminal, pedunculate, cymose-corymbose, laxly few-flowered, the branches strongly ascending, sparsely and minutely puberulent or glabrate; flowers disposed in few-flowered cymules, sessile or on stout pedicels scarcely 1 mm. long; calyx 5-fid to the

middle, the teeth triangular, acute or acuminate; corolla tubular-funnelform, minutely pulverulent outside, in bud with 5 short hornlike appendages at the apex, the lobes shorter than the tube.

Below the summit of Peak 7, 7050 ft., *669* (type); Desfiladero, 6100 ft., *712*. Like so many Psychotrias, the plant has no outstanding characters, but I have not been able to find a match for it among the South American species.

PALICOUREA MACROPHYLLA (HBK.) Standl. Agüita, 3100 ft., *886*. Ranging from Venezuela and British Guiana to Peru and Bolivia. A tree 7.5 m. high with large broad leaves; pedicels yellow; corolla white.

Perama scaposa Gl. & Standl., *op. cit.* 475. A slender annual, simple or with 1–2 branches from the base; lower leaves opposite, oblong-elliptic, the upper in a single whorl of 4, elliptic-ovate, 15–20 mm. long, densely villous on the upper surface, beneath villosulous on the nerves; inflorescence several times dichotomous or sometimes trichotomous, glabrous, almost naked and bearing only a few bracts scarcely 1 mm. long; flower-heads few, the peduncles almost filiform, 1–3 cm. long, about 10-flowered, the bracts linear, paleaceous; hypanthium paleaceous-pubescent; calyx-segments 2, fleshy, broadly triangular, acute, glabrous on the back; seeds globose, smooth, 0.7 mm. in diameter.

Summit of Peak 7, 7100 ft., *664* (type); sandy stream-bank at Central Camp, 4800 ft., *548;* Ridge 23c, *704;* Caño Sapo, 6200 ft., *597*. The corolla is described as white in some of the collections, and in one as blue. *Perama scaposa* belongs to the subgenus *Rosella* K. Sch., which is distinguished by subscapose habit and more or less rosulate leaves. The only other known species of the group is *P. dichotoma* Poepp. & Endl., recorded from the Amazon River and from Mount Roraima. In that the hypanthium is smooth and the seeds are 3-angled and punctate.

COMPOSITAE-EUPATORIEAE[1]

Lowland species

Eupatorium (§ CYLINDROCEPHALA) **Tyleri** Robinson, sp. nov. Frutex erectus, caulibus teretibus gracilibus breviter fulvidotomentellis, internodis plerisque 2–3 cm. longis. Folia opposita brevissime petiolata anguste ovata caudato-acuminata serrata basi cuneata 5–9 cm. longa 2–3 cm. lata distincte bicoloria supra obscure viridia (post exsiccationem fusco-brunnea) crispe puberula subtus fulvido-grisea breviter velutina paullo supra basin 3(–5)-nervia aliter pennivenia. Capitula ca. 11-flora parva vix 8 mm. longa pleraque breviter pedicellata in glomerulos paucos primo subsphaericos pani-

[1] By B. L. Robinson.

culatim dispositos aggregata. Involucri ca. 5-seriatim imbricati squamae ca. 20 subglabrae 3-striatae substramineae ciliolatae. Corollae glabrae 3 mm. longae. Achaenia 2.5 mm. longa basi conspicue attenuata.

A rather slender erect shrub; stems terete, shortly velvety with incurved or crisped slightly tawny grayish puberulence; internodes mostly 2–3 cm. long; leaves opposite, shortly petiolate, often proliferous in the axils, narrowly ovate, caudate-acuminate, finely serrate (the teeth 0.2–0.4 mm. high and 1–2 mm. wide at base), cuneate and entire at base, markedly discolorous, above dull green drying brownish gray, finely incurved-puberulent and gland-dotted, neither bullate nor rugose nor scabrid, beneath tawny gray, shortly velvety, rather obscurely 3(–5)-nerved from above the base, elsewhere pinnately veined, 5–9 cm. long, 2–3 cm. wide, thickish-membranaceous; petioles even of the largest leaves only 2–3 mm. long; panicle terminal, not obviously peduncled, opposite-branched, 7–15 cm. in diameter; heads about 11-flowered, scarcely 8 mm. long, shortly pedicelled or subsessile in terminal (at first subglobose) glomerules; phyllaries about 5-ranked, subglabrous dorsally, 3-striate, rounded at tip, ciliolate, closely appressed; corollas (probably purple) glabrous, 3 mm. long, without distinction of proper tube and throat; achenes nearly glabrous but minutely scabrid on the rather sharp angles, conspicuously attenuate at base, 2.5 mm. long; pappus of about 25 nearly smooth pale bristles equaling the corolla.

Rocky top of Esmeralda Ridge, *233*. This well marked species of § *Cylindrocephala* clearly approaches a plant of the Roraima Mountains, collected by Schomburgk and by him incorrectly identified with the Colombian *E. scabrum* L. f., from which it is clearly distinct, having smaller, mostly sessile heads, fewer florets and thicker, less attenuate and more shortly petioled leaves. From *E. Tyleri* this related species[1] of the Roraima Range differs in having harsher, conspicuously rugose leaves which are

[1] This plant seems to be undescribed. It may be here put on record as follows:

Eupatorium pharcidodes Robinson, sp. nov. Frutex ramosus, ramis teretibus fulvo-tomentellis, internodis 3–5 cm. longis. Folia opposita breviter petiolata ovata ad apicem obtusiusculum angustata basi rotundata vel subcuneata primo aspectu integra sed vero obscure lateraliter denticulata (dentibus utroque ca. 10 brevissimis) supra rugosissima scabridula atroviridia subtus fulvo-velutina 6–10 cm. longa 2.5–4.5 cm. lata, petiolo 2–5 mm. longo fulvo-tomentoso. Corymbi in caule ramisque terminales convexi 6–12 cm. diametro. Capitula ca. 8-flora sessilia vel breviter pedicellata in glomerulos subsphaericos aggregata. Involucri graciliter cylindrici squamae 6–7-seriatim imbricatae arcte adpressae apice rotundatae ciliatae dorso pallide brunneae tenuiter 3–5-nervatae. Achaenia nigra sed cum costis pallidis instructa deorsum attenuata sursum in angulis scabrida 3.5 mm. longa, pappi setis ca. 25 albidis. "*E. scabrum*" Schomburgk, Vers. Fl. Brit.-Guiana, 1077, 1848, not L. f.

In sparsely shrubby places on the southern slopes of Mt. Roraima, *Schomburgk*, no. *187.5* (type in herb. Royal Gard. Kew, phot. in Gray Herb.).

much less narrowed toward the tip and base and are subentire or but obscurely 8–10-toothed on each side instead of being, as in *E. Tyleri*, definitely serrate with 15–20 teeth on each side.

EUPATORIUM ODORATUM L. In forest, Santa Isabel, Rio Negro, northern Brazil, *76*. A species common throughout the warmer parts of America, variable and running to several conspicuously diverse yet by no means sharply definable strains. The plant of Tate here in question would be referable to *E. Maximiliani* var. *hispidum* DC. were that variety or even the species *E. Maximiliani* Schrad. capable of satisfactory delimitation from the more general concept of the older *E. odoratum* L.

Species of Mount Duida

Eupatorium (§ EXIMBRICATA) **Tatei** Robinson, sp. nov. Frutex ut videtur erectus, caulibus ramisve adscendentibus virgatis teretibus foliosis scabris densissime fusco-puberulis, capillis patentibus sursum curvatis acutis basi incrassatis et aetate papilliformibus. Folia opposita vel subalterna (paribus saepe paullo disjunctis) breviter petiolata elliptica vel obovata ad apicem versus paucidentata rigida punctata utrinque glabra ca. 3 cm. longa 1.2–1.8 cm. lata. Panicula terminalis convexa vel subpyramidata, pedicellis gracilibus flexuosis 3–8 cm. longis. Capitula ca. 6-flora 8 mm. alta; involucri squamis paucis dorso fusco-puberulis, principibus subaequalibus oblongis obtusis, extimis 2–3 lanceolatis acutis multo brevioribus. Achaenia 3 mm. longa scabrata deorsum attenuata.

A shrub with erect or ascending virgate terete and leafy branches, the stems, branches, petioles, pedicels and phyllaries covered with a close scabrid puberulence almost black in color. Leaves opposite or nearly so, narrowly obovate or more often elliptic, shortly few-toothed toward the obtuse to rounded apex, entire and subcuneate toward the base, rigid, glabrous and punctate on both surfaces, above slightly shining, 3-nerved from near the base, otherwise pinnately veined; petiole 2–3 mm. long. Panicle convex or low-pyramidal; heads small, about 6-flowered; phyllaries of two kinds, the inner oblong or even elliptical, obtuse or rounded at the tip, subequal and loosely imbricated, the outer (2–3) lanceolate, acute, much shorter. Corollas purplish, subcylindrical, about 5 mm. long. Achenes dark, about 3 mm. long, slightly tapering toward the base, scabrid; pappus-bristles 25–30, sordid (in dried material), equaling the corolla.

Slopes of Ridge 25, 5500–6000 ft., *414* (type); summit of Peak 7, 7100 ft., *641*. This endemic species in its habit, nigrescent pubescence and some other features recalls *E. fuscum* N. E. Br. of the Roraima Mountains, which may probably be regarded as its nearest known relative. However, the two are quite distinct, *E. fuscum* having broader, more ovate leaves, rounded at the base and pubescent beneath, 15–16-flowered heads, and acute inner phyllaries.

Mikania (§Thyrsigerae) **duidensis** Robinson, sp. nov. Suffrutex vel frutex volubilis ubique cum pilis viscidis patentibus et saepissime retrorsis nodulosis fusco-purpureis obtectus. Folia (saltem caulina) opposita bene petiolata suborbiculari-ovata breviter acuminata basi sinu angusto cordata margine cuspidatim denticulata. Capitula subsessilia ad apices ramulorum brevium patentium inflorescentiarum lateralium vel terminalium aggregata; involucri squamis anguste oblongis apice rotundatis ca. 8 mm. longis dorso fusco-villosulis basi gibbosis et paullo incrassatis. Corollae glabriusculae, tubo proprio gracili, faucibus turbinato-campanulatis, dentibus limbi oblongis acutiusculis. Achaenia matura ignota.

A slender tough-stemmed somewhat lignescent twiner covered with a dark and viscid pubescence; internodes subterete, 8–15 cm. long, flexuous; nodes slightly thickened but destitute of stipuliform appendages; hairs jointed, attenuate, setiform, dark purple, spreading or reflexed, short, not capitate; leaves opposite, petiolate, the cauline suborbicular-ovate, shortly acuminate, at base cordate by a narrow sinus and with rounded basal lobes, obscurely and remotely cuspidate-denticulate, fuscous-pubescent on both surfaces, thickish in texture, 3–5-nerved from the base; the limb 4.5–6 cm. long, 4–4.5 cm. wide; petiole 2–2.5 cm. long, densely dark-pubescent; uppermost and rameal leaves smaller, suborbicular, obtuse or rounded at each end; panicles axillary or terminal, pedunculate, leafy-bracteate toward the base; heads glomerate at the tips of the spreading branchlets, subsessile; phyllaries narrowly oblong, rounded at tip, about 8 mm. long, coarsely dark-puberulent on the back, swollen and slightly corky toward the base; corollas subglabrous at maturity, the proper tube slender, 3.5 mm. long, the throat turbinate-campanulate, 2.5 mm. long; teeth oblong, acutish, 1.5 mm. long; mature achenes not known.

Slopes of Ridge 25, 5500–6000 ft., *426* (phot. and small fragm. in Gray Herb.); Burned Mountain, 6500 ft., *1050*. The type, which is the better specimen, is unfortunately overmature and though retaining its involucres has shed its florets. After careful search a single corolla was discovered adhering to the involucre but even this had dropped its achene. The second plant cited, namely no. *1050*, is clearly the same species though showing only the upper smaller and more obtuse leaves. It is in bud stage, but shows that the pappus-bristles are about 33 in number, smoothish, salmon-colored (after drying) and about the length of the corolla. In habit and indument this species differs much from any *Mikania* previously known in Venezuela. It slightly recalls *M. phaeoclados* Mart. of eastern central Brazil but has longer darker pubescence, somewhat larger, more pointed and more finely toothed leaves, longer and stouter petioles, as well as other differences.

COMPOSITAE—A NEW GENUS[1]

Among the collections obtained on the Tyler-Duida Expedition of 1928–1929 is a plant which at first sight was taken to be a *Senecio*. Critical examination, however, proved it to be not of this genus, but apparently an undescribed member of the Compositae of doubtful generic affinity. The alternate or scattered leaves, the two- to three-seriate somewhat stramineous bracts of the involucre, the naked conical receptacle, and the numerous unequal scales of the pappus would seem to place the plant in question in the *Helenieae-Jauminae*, allied to *Geissopappus*. Further collections, however, may reveal a more definite relationship within the family. The unusual combination of characters warrants placing on record the following description:

Tyleropappus Greenman, gen. nov.

Capitula terminalia mediocria homogama discoidea. Involucrum campanulatum, bracteis 2–3-seriatis linearibus vel oblongis submembranaceis striatis plus minusve straminibusque, exterioribus brevioribus. Receptaculum conicum nudum. Corollae disci regulares, tubo brevi, limbo abrupte ampliato campanulato, apice 5-fido. Antherae basi obtusi vel brevi sagittatae, apice appendiculatae. Styli rami lineares, apice breviter conici obtusique. Achenia oblongo-linearia vel obconica. Pappi paleae numerosae uniseriatae inaequales. Plantae suffruticosae, ramis plus minusve dichotomis. Folia alterna.

Tyleropappus dichotomus Greenman, sp. nov. Fruticosa ca. 3 dm. alta; caule tereti plus minusve dichotomo-ramoso, ramis superne foliosis inferiore nudatis juventute dense hirtello-pubescentibus deinde glabratis et griseo cortice obtectis; foliis alternis sessilibus vel brevi-petiolatis linearibus vel anguste lanceolatis 0.5–2 cm. longis 1–2.5 mm. latis acutis integerrimis utrinque glabris subtus pallidioribus subpunctatisque, marginibus revolutis; capitulis ad apices ramulorum in subcorymbocymis dispositis sessilibus vel brevi-pedunculatis paucifloris; involucri squamis extimis linearibus vel lineari-lanceolatis acutisque, extimis oblongis obtusis striatis paululo stramineis glabris; corollis tubulo-campanulatis ca. 4 mm. longis profunde lobatis glabris vel parce glandulosis aurantiacis; tubo proprio ca. 1.5 mm. longo; faucibus abrupte ampliatis; achaeniis obconicis ca. 2 mm. longis sursum adpresso-hirsutis; pappi paleis numerosis anguste lanceolatis 2–4 mm. longis eroso-ciliatis inaequalibus.

Pl. 39, fig. 1. Part of the type specimen, natural size. Pl. 40. A. Head ×8. B. Receptacle ×4. C. Involucral bracts ×8. D. Complete flower ×8. E. Flower after removal of pappus ×10. F. Corolla showing insertion of stamens ×10. G. Anthers ×10. H. Scale of pappus ×10. I. Pistil ×10. J. Mature achene with persistent pappus ×5.

[1] By J. M. Greenman.

Summit of Peak 7, 7100 ft., *605* (phot. and fragment in Herb. Missouri Bot. Gard.); a shrub 1 ft. high with yellow flowers.

The plant described above resembles *Dyscritothamnus filifolius* Robinson, but differs from that genus in several important details, particularly in the character of the involucre, absence of pales on the receptacle, in having a distinctly paleaceous instead of a setose pappus, in the shape of the corolla, and in the character of the style-branches.

The drawings illustrating this species have been made by Miss Josephine Darlington.

COMPOSITAE—REMAINING GROUPS[1]

Lowland species

Polymnia stenocarpha Blake, sp. nov. Herba (?) dichotoma, caule tenui dense patenti-piloso pilis articulatis; folia opposita parva ovata acuta vel acuminata basi rotundata vel subcordata crenato-serrata utrinque dense sordido-pilosa subtus reticulato-venosa brevipetiolata; capitula in apicibus caulis ramorumque 1–3 minuscula brevipedunculata aurea; involucri semiglobosi ca. 5 mm. alti phyllaria ca. 4-seriata subaequalia extima 2 ovata herbacea utrinque dense pilosiuscula interiora pauca dense puberula; radii 7 parvi; flores disci 20 steriles; paleae parvae angustae; achenia crassa quadrangularia paullum compressa glabra annulo crasso coronata.

Plant apparently herbaceous, 35 cm. high or more, a few times dichotomously branched; stem subterete, 2.5 mm. thick below, flexuous, solid, densely griseous-pilose with spreading or spreading-ascending hairs; internodes 1.5–4 cm. long; petioles naked, densely pubescent, 1.5–3 mm. long; blades ovate or oblong-ovate, 2.5–3.5 cm. long. 9–14 mm. wide, firmly herbaceous, crenate-serrate with about 7 pairs of small callous-pointed teeth incurved beneath the lower surface of the blade, above dull green, densely and rather softly pilose with tuberculate-based antrorse-curved hairs, beneath densely griseous-pilose with spreading or antrorse-curved hairs, 5-pli-nerved within 2 mm. of base of blade (the upper pair of nerves stronger, extending nearly to tip of leaf) and strongly prominulous-reticulate beneath; heads 1 cm. wide, 1–3 in forks of stem and at tips of branches, apparently recurving in fruit, on densely pilosulous pedicels about 5 mm. long; disk 5 mm. high, about 6 mm. thick; 2 outer phyllaries 6 mm. long, 4–5 mm. wide, 5-pli-nerved, obtusely pointed, the next ones subherbaceous above, the inner suborbicular-ovate, with subindurate many-vittate puberulous body and short scarious glabrous erose apex; receptacle flat; pales linear-lanceolate, acuminate, glabrous, 1-vittate, 3 mm. long; rays 4.5 mm. long, the tube pilose, 1.8 mm. long, the lamina wedge-obovate, 2.7 mm. long, 2 mm. wide, repand or biemarginate; disk corollas narrowly funnelform, sparsely pilose at base, 3.5 mm. long (teeth 5, tri-

[1] By S. F. Blake.

angular, 1.1 mm. long); disk achenes abortive, glabrous, 0.4 mm. long; ray achenes bluntly quadrangular with rounded faces, 2.5 mm. long, 1.5 mm. wide, vertically raised-lineolate, brownish, glabrous, abruptly contracted at the truncate-rounded apex into a thick collar about 0.2 mm. high, epappose; style of disk flowers merely papillate, truncate, entire, not thickened above.

Rocky top of Esmeralda Ridge, *208*. This species, well distinguished from others of the genus by its small leaves and its solitary or few, short-peduncled, rather small heads, is aberrant in the oval-oblong, scarcely at all oblique, nearly evenly quadrangular ray achenes and the very narrow pales of the disk. The broad bracts subtending the ray achenes are flattish, concave in middle to receive the achenes, but not at all infolding them. These minor technical differences are by no means of generic importance.

ACANTHOSPERMUM AUSTRALE (Loefl.) Kuntze. Tinahy, Rio Negro, northern Brazil, *117*. Nearly throughout South America, but not on the Pacific coast; also (introduced) in the United States, Lesser Antilles, Hawaiian Island, and India.

ERECHTITES HIERACIFOLIA (L.) Raf. Yucabí, Rio Negro, northern Brazil, *127*. Widespread from Canada to southern South America.

Species of Mount Duida

BACCHARIS SCHOMBURGKII Baker. Summit of Peak 7, 7100 ft., *631;* otherwise known only from Mount Roraima. I cannot distinguish this specimen (staminate) in any way from a specimen in the U. S. National Herbarium of *Schomburgk 707* (also staminate), the type collection of the species. The locality was given by Baker as British Guiana only, but our specimen bears an original printed label giving the locality as Roraima. Perhaps this is the unidentified species related to *B. cassinefolia* DC. recorded by Oliver (without specific locality) and by Burkill from "summit" of Mount Roraima.

Calea abelioides Blake, sp. nov. Frutex ramosus semimetralis, ramulis hexagonis glanduloso-punctatis novellis parce incurvo-hispidulis, internodiis brevibus; folia opposita parva ovata acuminata basi rotundata pauciserrata glaberrima subtus dense glanduloso-punctata coriacea 5-pli-nervia et reticulato-venosa brevipetiolata; capitula 10-flora discoidea parva in apicibus ramulorum 3–9 umbellatim congesta, pedicellis 1–3 mm. longis; involucri gradati glabri 6 mm. alti phyllaria 2 exteriora lanceolata obtuse acuminata maxima ex parte herbacea 3–4 mm. longa; pappi paleae ca. 15 achaenio hispidulo duplo longiores.

Trichotomously branched undershrub, glabrous throughout except for some sparse puberulence on the youngest branches; stem and older branches

subterete, with grayish-brown bark, the younger 6-striate-angled, glandular in the grooves; internodes mostly 4–12 mm. long; petioles slender, 1 mm. long; blades 1.6–2.5 cm. long, 6–11 mm. wide, 3–4-serrate on each side mostly above the middle (teeth gland-tipped, about 0.3 mm. high, 2–5 mm. apart), somewhat shining above, densely dotted with yellowish glands beneath, the 2 lower pairs of veins arising within 1.5 mm. of base of leaf, the upper pair stronger than the lower and continuing practically to tip of leaf; pedicels obscurely puberulous, glabrate; heads cylindric-oblong, about 3 mm. thick; phyllaries graduate, the 2 outer sessile-glandular outside, the others about 5-seriate, broadly ovate to oblong or oblong-ovate, obtuse, with indurated several-vittate body and subscarious margin and tip, not ciliate; very young pales lanceolate, acuminate, lacerate toward apex; submature achene 1.5 mm. long; pappus paleae 15 or more, lance-linear, acuminate, hispidulous, 3.2 mm. long.

Ridge crests, Savanna Hills, 4400 ft., *768*. *Calea abelioides*, named from its striking habital resemblance to such species of *Abelia* as *A. chinensis* R. Br., is a member of the subgenus *Eucalea* and is well distinguished by its small, coriaceous, glabrous leaves, densely gland-dotted beneath, and its clusters of small, short-pedicelled heads. It belongs in a different subgenus from *Calea oliverii* Robins. & Greenm. (*C. ternifolia* Oliv., not HBK.), the endemic species of the Roraima region. *Calea ternifolia* Oliv. was described from the Arapoo River, which flows down from Roraima, but is mentioned by im Thurn[1] as one of the plants characteristic of the mountain.

Stenopadus Blake, gen. nov.

Frutices vel arbores, ramis saepius strigosis. Foliia alterna plusminusve obovata integra coriacea petiolata penninervia et reticulato-venosa vel 1-nervia et subevenia glabra vel mox subglabra. Capitula majuscula vel magna solitaria vel pauca terminalia homogama ca. 10–45-flora, floribus omnibus hermaphroditis uniformibus. Involucri obovoidei basi angustati valde gradati multiseriati phyllaria coriacea appressa maturitate decidua. Receptaculum planiusculum glabrum, paleis angustissime linearibus elongatis firmis flexuosis subpersistentibus flores subtendentibus onustum. Corollae regulares glabrae vel in apice tubi hispido-barbatae, tubo anguste infundibuliformi vel cylindrico limbi 5-partiti segmentis valde revolutis vel rigidis et erectis longiore vel subaequali vel 2–4-plo breviore. Achenia majuscula vel mediocria columnari-prismatica acute 4–5-angulata ca. 10–12-costata glabra, collari pappifero nullo. Pappi multiseriati gradati persistentis setae paullum complanatae minute hispidulae, intimis magis complanatis apice paullum dilatatis. Antherae caudato-sagittatae, appendicibus terminalibus lanceolatis acuminatis,

[1] Trans. Linn. Soc. Bot. II. 2: 260, 1887.

caudis lanceolatis acuminatis glabris vel hispidulis, contiguis connatis. Stylus supra serrulato-asperulatus glaber, ramis brevibus oblongis vel ovatis obtusis glabris erectis vel semipatentibus.—Species typica *S. talaumifolius*, n. sp.

A genus of the *Mutisieae-Gochnatinae*, allied to *Wunderlichia* Riedel and *Stifftia* Mikan, from both of which it is distinguished at once by the presence of very narrow pales on the receptacle at the base of each flower. The genus may be inserted in the system directly after *Wunderlichia*. In *Stifftia* (*Augusta* Leandro) the receptacle is naked, glabrous, shallowly and bluntly alveolate; the achenes are more or less fusiform with a short pappiferous collar, and (at least in *S. chrysantha* Mikan, type of the genus) distinctly flattened and 10-ribbed, with rounded, not in the least angled sides; the anther-tails are free; and the style is not serrulate-asperulous above. The corollas and pappus do not differ from those of *Stenopadus*. In *Wunderlichia* (of which I have examined only the unpublished *W. tomentosa* Glaz., evidently a very close ally of *W. mirabilis* Riedel, the original species), each flower is apparently completely surrounded by a series of stiff, deeply lacerate, irregularly connate, stramineous, glabrous pales about 2.3 cm. long, breaking up into narrowly linear, attenuate, lacerate divisions 1.5 mm. wide or less; the achenes, although somewhat 4–5-angled when young, are at maturity subterete, somewhat fusiform (distinctly contracted at least above), and about 10-ribbed; the pappus, in general features similar to that of *Stenopadus*, is deciduous in a ring or at least in large groups of bristles, and the plants are densely pannose- or lanate-tomentose, at least on the younger parts, with large suborbicular or broadly obovate leaves densely crowded at tips of branches. The styles and anthers do not differ essentially from those of *Stenopadus*.

The species of *Stenopadus* (*στενός narrow, ὀπαδός a follower*, from the narrow receptacular pales) divided naturally into two groups, which may be defined as follows:

Eustenopadus Blake, subgenus nov. Folia reticulato-venosa; corollae glabrae, limbi segmentis valde revolutis tubo brevioribus vel subaequalibus. Species typica *S. talaumifolius*, sp. nov.

Stomatochaeta Blake, subgenus nov. Folia 1-nervia subevenia; corollae in apice tubi annulo hispido-barbato donatae, limbi segmentis rigidis erectis tubum subduplo usque ad quadruplo superantibus. Species typica *S. crassifolius*, sp. nov.

Stifftia Connellii N. E. Br., considered by its author a connecting link between *Stifftia* and *Wunderlichia*, entirely agrees in essential characters with the two new species of the subgenus *Eustenopadus* described below and should be transferred to the present genus as **Stenopadus Connellii**

(N. E. Br.) Blake, comb. nov. Brown was of the opinion that when more species were discovered *Stifftia* and *Wunderlichia* would require to be united. The technical distinctions between the three groups here treated as genera are numerous and important, however, and the presence of recognizable group differences in gross characters strengthens the generic separations here made.

Stenopadus talaumifolius Blake, sp. nov. Arbor ramosa 6 m. alta, ramis crassis infra denudatis glabratis, novellis dense foliosis dense strigillosis; folia alterna obovata obtusa vel retusa basi cuneata petiolata integra coriacea penninervia reticulato-venosa glabra; capitula 1–3-na sessilia vel brevipedunculata majuscula ca. 15-flora homogama; involucri 3.8 cm. alti subcylindrici basi angustati valde gradati ca. 11-seriati appressi phyllaria coriacea strigillosa et ciliata glabrescentia exteriora ovata obtusa intima linearia acuminata; corollae 3.6 cm. longae glabrae, tubo limbi segmentis revolutis paullo longiore.

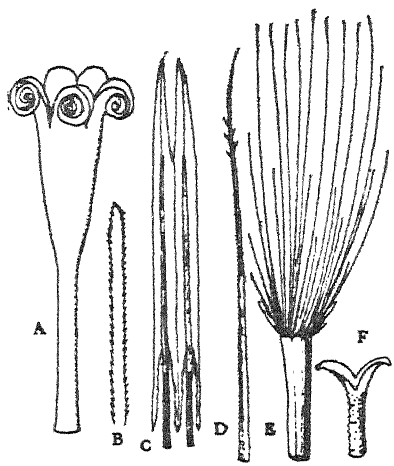


Fig. 6. *Stenopadus talaumifolius.*

Older branches subterete, striate, gray-barked, 5 mm. thick, those of the year gray-brown; internodes about 1–5 mm. long; petioles stout, 5–10 mm. long, narrowly margined above, strigillose, glabrate; blades 4.5–10.5 cm. long, 2.5–5.5 cm. wide, narrowly marginate, shining, light green above, lighter brownish-green and whitish-papillate beneath, the costa stout, prominent beneath, the principal lateral veins about 8–10 pairs, prominulous-reticulate on both sides; peduncles wanting or 1 cm. long, stout, strigillose; disk 4 cm. high, about 2 cm. thick in fruit; phyllaries (except the inmost) pale brown, coriaceous with thinner margin, the outermost ovate, about 3 mm. long, 2.5 mm. wide, the next ones ovate, 7–9 mm. long, 3–6 mm. wide, the middle ones lance-oblong to lanceolate, acute or acuminate to an obtuse apex, 1.5–2. cm. long, 3.5–6 mm. wide, the innermost somewhat thinner but firm, linear, acuminate,

1.5 mm. wide; receptacle flattish, glabrous, the pales very narrowly linear, 3 cm. long, about 0.4 mm. wide, about equaling the pappus, stiff, acuminate, minutely serrulate-hispidulous, the apex slightly dilated; corollas fleshy, the tube 1.8–2 cm. long, cylindric to middle, then funnelform, 3 mm. wide at apex, the throat none, the segments linear-triangular, acuminate, strongly revolute, 2-nerved, 1.6 cm. long; achenes columnar-prismatic, about 4-angled and 12-ribbed, 9 mm. long, glabrous, blackish-brown, not contracted at apex and without obvious pappiferous collar; pappus multiseriate, graduate, 2.3 cm. long, the bristles numerous, whitish, slightly flattened, hispidulous, the inner with somewhat dilated and bent tips, the outermost only 2 mm. long; anthers olive-green, 13 mm. long, the terminal appendages lanceolate, acuminate, about 3 mm. long, the sacs about 6.5 mm. long, the tails lanceolate, acuminate, 3.5 mm. long, backward-serrulate or hispidulous, those of adjacent anthers connate in pairs to apex; style finely serrulate-roughened above, the branches oblong, half-spreading, obtuse, glabrous, 1.3 mm. long. (Pl. 41.)

Fig. 6. A. Corolla ×2. B. Tip of one of the longer pappus-bristles ×10. C. Anthers ×4. D. Pale ×2. E. Achene (part of pappus omitted) ×2. F. Style-tip ×5.

Dryish slopes of Savanna Hills, 4400 ft., *759*. Distinguished from *Stenopadus Connellii* (N. E. Br.) Blake by its much smaller heads and narrower leaves, and from *S. eurylepis*, described below, by its about 15-flowered heads and much narrower phyllaries.

Stenopadus eurylepis Blake, sp. nov. Frutex ramis crassis dense strigosis; folia subconferta alterna obovata obtusa basi cuneata petiolata integra crasse coriacea penninervia utrinque prominulo-reticulata glabra, costa strigosa excepta; capitula solitaria sessilia majuscula 28–30-flora homogama; involucri gradati ca. 3.7 cm. alti phyllaria exteriora late ovata obtusa ciliata et dense rufescenti-strigosa media oblonga apice paullum dilatata intima linearia apice ciliata; corollae glabrae 3.8 cm. longae, tubo limbi segmentis dimidio longiore.

Branch about 5 mm. thick near tip, gray-strigose; branchlet of the year 3 mm. thick, angled, rufescent; petioles 8–13 mm. long, stout, naked, densely strigose; blades 5–12.8 cm. long, 2.3–5 cm. wide, normally obtuse, occasionally retuse or obcordate, often somewhat inaequilateral, scarcely marginate, somewhat shining, light-papillate beneath, penninerved, the lateral veins about 13–18 pairs, of which 7–8 pairs are stronger and anastomose near the margin; phyllaries with olive-brown base, deep brown upper portion, and narrow pale brownish margin, coriaceous with thinner margin, the outer 6–15 mm. long, 3.5–9 mm. wide, rounded, the middle ones 2.5 cm. long and 7 mm. wide, rounded, usually slightly contracted below apex, then barely ampliate, pubescent like the outer, the innermost linear, rounded or subtruncate, 2–3.5 mm. wide; pales very narrowly linear, 3.5 cm. long, about 0.2 mm. wide, firm, at apex slightly dilated and ciliate; corolla-tube 2.2 cm. long, narrowly funnelform, the throat wanting, the 5 segments of limb linear-triangular, acuminate,

strongly revolute, 1.6 cm. long, 1.5 mm. wide at base; achenes columnar-pentagonal, about 10-ribbed, 11 mm. long, about 1.8 mm. thick, glabrous, blackish-brown, shining; pappus multiseriate, graduate, 2.3 cm. long, whitish, the bristles slightly flattened, hispidulous, the longer slightly dilated at apex; filaments elongate, slender, triangular-dilated at base and there with a few bristles, the anthers 13 mm. long, the terminal appendages lanceolate, acuminate, connate below, 5 mm. long, the sacs 5.5 mm. long, the tails 2.5 mm. long, lanceolate, acuminate, those of adjacent anthers connate in pairs; style finely serrulate-roughened above, the branches not seen.

At Agüita, 3100 ft., *935*. The material examined consists of four tips of branches 6 cm. long or less, with numerous detached leaves, flowers, and achenes. Three of the branches bear receptacles, in two instances with a few persistent pales, but in all the involucres have fallen entirely and are represented only by loose phyllaries in the pockets, so that the description of the involucre given above is necessarily imperfect.

Stenopadus crassifolius Blake, sp. nov. Frutex 0.3 m. altus dichotome ramosus; rami crassi infra denudati densissime strigillosi, novellis rufescentibus; folia ad apices ramorum subconferta alterna obovata retusa basi rotundata integerrima plana crasse coriacea marginata crasse petiolata ad basin costae utrinque strigillosa ceterum glabra utrinque inconspicue papillata 1-nervia venis 3–4-jugis immersis; capitula in apicibus ramorum 1–2 sessilia vel brevipedunculata majuscula ca. 45-flora homogama; involucri ca. 7-seriati ca. 2.3 cm. alti phyllaria exteriora deltoideo-ovata acutiuscula coriacea ciliata ceterum glabra, intima angustissime linearia; corollae 2.7 cm. longae limbi 5-partiti segmenta 5 rigida erecta lineari-triangularia tubum apice intus hispido-barbatum duplo superantia.

Younger branches angulate, about 3 mm. thick, the older subterete, grayish, 5 mm. thick; internodes of young growth 3–15 mm. long; petioles flattened, densely strigillose, 5 mm. long; blades 3.3–7 cm. long, 1.5–3.5 cm. wide, often unequal at apex, rounded or cuneate-rounded and often unequal at base, brownish-green when dried, the thickened margin about 0.2 mm. wide; peduncles (present only when heads are paired, and then only in the lateral head) about 8 mm. long, thick, densely rufescent-strigose; disk of submature heads (excluding corollas) thick-cylindric, 3 cm. high; involucre strongly graduate, the outer phyllaries (several series) deltoid-ovate, 6–12 mm. long, about 6 mm. wide, acutish, coriaceous, chestnut-brown with narrow paler brown margin, densely pilose-ciliate, otherwise glabrous, the middle ones similar, lance-oblong, acuminate, 3–4 mm. wide, the innermost narrowly linear, acuminate, hispidulous-ciliolate, 0.7–1.5 mm. wide; receptacle flattish, the narrowly linear pales 2.4 cm. long, equaling the pappus, firm, acuminate, slightly dilated at apex, hispidulous-ciliolate; corollas apparently whitish, glabrous except for the dense hispidity at apex of tube within, the tube 9 mm.

long, the throat wanting, the lobes 1.8 cm. long, 0.8 mm. wide at base; achenes oblong, 7 mm. long, 1.5–2.5 mm. wide, about 10-ribbed, often obcompressed, more or less distinctly 4–5-angled, blackish-brown, glabrous, shining; pappus multiseriate, graduate, 1.8 cm. long, the numerous bristles (or setiform awns) becoming brownish, very numerous, persistent, slightly flattened, hispidulous, not thickened at apex, the short outermost ones only 4 mm. long; anthers 9.8 mm. long, the lanceolate acuminate terminal appendages yellowish, 3 mm. long, the sacs 4 mm. long, the lanceolate acuminate apically subobtuse tails 2.8 mm. long, connate in pairs, slightly retrorse-hispidulous; style at maturity

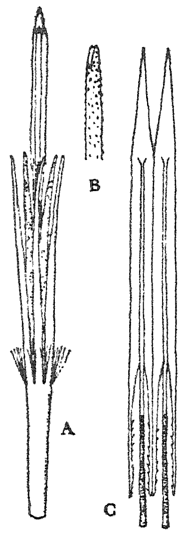


Fig. 7. *Stenopadus crassifolius.*

surpassing the stamens by 3 mm. or more, slender, toward apex slightly thickened and finely serrulate-roughened like the lower back of the style branches, these very short, erect, ovate, rounded, glabrous, 0.4 mm. long.

Fig. 7. A. Corolla ×2. B. Style-tip ×5. C. Anthers ×6.

Central camp, *1014* (type); slopes of Ridge 25, 5500–6000 ft., *415*.

Gongylolepis glaberrima Blake, sp. nov. Frutex ubique glaber, ramis crassis; folia alterna saepius conferta obovata obtusa vel retusa basi rotundata vel cuneata brevipetiolata integra crasse coriacea penninervia prominulo-reticulata; capitula solitaria sessilia terminalia majuscula 13–15-flora homogama; involucri 3.5 cm. alti valde gradati phyllaria extima ovata intima anguste oblonga omnia rotundata vel obtusa intima subscariosa, ceteris coriaceis; corollae bilabiatae 2.8 cm. longae; pappi 14 mm. longi gradati rufescentis setae pallulum complanatae minute hispidulae.

Shrub (or tree ?), strictly glabrous throughout; branches apparently simple, 5–8 mm. thick, usually strongly cross-ridged by the scars of fallen leaves; internodes usually 2–5 mm. long, sometimes up to 12 mm.; petioles 3–9 mm. long, about 5 mm. wide; blades cuneate-obovate to oval-obovate, 4–9 cm. long, 2–6 cm. wide, with very narrowly revolute margin, penninerved and densely prominulous-reticulate especially beneath, the lateral veins about 8–18 pairs, strongly anastomosing; involucre about 7-seriate, thick-cylindric, the phyllaries all appressed, the outer 6–8 mm. long, 4–6 mm. wide, coriaceous, deep chestnut brown, with paler brown border and narrow scarious margin, the middle ones similar but oblong or ovate-oblong, about 5 mm. wide, the innermost mostly scarious, 3.5–4 mm. wide, minutely erose at tip; receptacle flattish, short-hirsute, epaleaceous; corollas glabrous, the tube 1.4 cm. long, slender-funnelform, the outer lip triangular-oblong, 3-toothed, 6-nerved, 1.4 cm. long, about 4 mm. wide at base, the inner lip 2-parted, the segments revolute, lance-linear, 14 mm. long, 1.3 mm. wide at base; achenes columnar, 8 mm. long, about 10-nerved, deep brown, glabrous, bearing a pappiferous collar at apex; pappus multiseriate, graduate, 14 mm. long, rufescent, the bristles numerous, slightly flattened, minutely hispidulous, fragile, the outermost only 1 mm. long; anthers 15 mm. long, the terminal appendages lance-linear, acute, connate below, 3.5 mm. long, the sacs 6.5 mm. long, the tails 5 mm. long, lance-linear, acuminate to obtusish, finely hispidulous, all connate for about 2/5 their length or nearly to apex; style smooth, the branches oblong, 1.3 mm. long, subtruncate, obscurely 3-lobed, glabrous.

Summit of Peak 7, 7100 ft., *614*, *617* (type), *647;* ridge top, 6000 ft., *1013*. The material of this species is somewhat variable. No. *1013* has the only head in flower present in the specimens examined; the heads of no. *617*, from which the details of receptacle are taken, are not yet opened, and the other numbers are without heads. In no. *1013* the leaves are comparatively remote, the internodes being mostly 1 cm. long or somewhat more; in all the others the leaves are crowded and the branches strongly cross-ridged. In no. *647* and *1013* the leaves are larger and more cuneate-obovate, in the other two more oval-obovate and rounded at base. All appear, however to belong to one species. *Gongylolepis glaberrima* is distinguished from the only previously known species, *G. Benthamiana* Rob. Schomb., by its solitary sessile heads, and from *G. erioclada*, described below, by its completely glabrous character, as well as by its considerably larger heads. The relationships of the genus *Gongylolepis* Rob. Schomb., incorrectly referred by Bentham and Hooker to the synonymy of *Stifftia*, will be discussed by the writer in a forthcoming paper in the American Journal of Botany.

Gongylolepis erioclada Blake, sp. nov. Frutex ramis densissime subsericeo-piloso-tomentosis, aetate subglabratis; folia alterna crebra obovata vel ovalia

acuta vel obtusa basi rotundata vel cuneata integra coriacea utrinque parce piloso-tomentosa saepius glabrata penninervia reticulato-venosa; capitula solitaria sessilia terminalia 9-flora homogama; involucri ca. 2 cm. alti valde gradati phyllaria coriacea anguste scarioso-marginata glabra extima ovata intima anguste oblonga, omnia rotundata vel obtusa; corollae bilabiatae 19 mm. longae.

"Straggling bush, 3 m. high;" branches subterete, usually striate, about 3 mm. thick, at first very densely pilose-tomentose with subsericeous whitish hairs, in age finely gray-tomentulose; internodes 3–7 mm. long; petioles 2–4 mm. long, flattened, broad, pilose-tomentose, glabrescent; blades 2.5–6 cm. long, 1.2–2.3 cm. wide, with very narrowly revolute margin, above shining green, quickly glabrate or remaining thinly pilose, beneath lighter green, thinly pilose-tomentose (densely so toward base of costa) or glabrate, penninerved, the principal veins about 8–13 pairs, anastomosing, prominulous especially beneath; disk thick-cylindric, 2 cm. high; involucre 2–2.2 cm. high, about 6-seriate, appressed, the phyllaries comparatively few, with olive or deep brown, puncticulate, coriaceous body and narrow scarious margin (minutely erose above), the outer 4–7 mm. long, about 3.5 mm. wide, the middle oblong, about 4 mm. wide, the innermost narrowly oblong, 2.5 mm. wide; corollas glabrous, the tube 9 mm. long, the outer lip oblong, 3-denticulate, 10-nerved, 10 mm. long, 4.5 mm. wide at base, the inner lip 2-parted, the segments lance-linear, acuminate, 2-nerved, 10 mm. long, 1.3 mm. wide at base; achenes subcylindric, 8 mm. long, contracted above, then widened into a pappiferous collar, about 10-nerved, glabrous, brown; pappus multiseriate, graduate, 12 mm. long, rufescent, the bristles slightly flattened, hispidulous, the outermost only 2 mm. long; anthers 11 mm. long, the terminal appendages lanceolate, acute, about 2.5 mm. long, the sacs 5 mm. long, the tails 3.5 mm. long, linear, acutish, all connate for about half their length, slightly hispidulous; style glabrous, not enlarged above, the branches oblong, half-spreading, 2.2–2.5 mm. long, glabrous, subtruncate, irregularly 3–4-lobulate at apex.

Dry slopes of Savanna Hills, 4400 ft., *758*.

Duidaea Blake, gen. nov.

Frutices ramis infra denudatis, supra conferte foliosis. Folia alterna subacicularia vel anguste linearia coriacea integerrima 1-nervia subsessilia. Capitula ratione parva vel magna solitaria terminalia pedunculata homogama 9–21-flora, floribus omnibus bilabiatis uniformibus vel exterioribus labio exteriore plusminusve longiore. Involucri subcylindrici aetate subturbinati gradati multiseriati phyllaria triangularia ad oblonga vel intima linearia saepius acuminata vel acuta straminea vel pergamentacea, intima subscariosa, extima interdum subcoriacea. Receptaculum planum epaleaceum hirsutum. Corollae bilabiatae, labio exteriore 3-dentato erecto interiore 2-partito revoluto. Achenia plusminusve fusiformia subteretia ca. 10-costata plus-

minusve hirsuta vel hirsutula, collari pappifero nullo vel obscuro. Pappi non copiosi gradati pauciseriati straminei persistentis setae hispidulae vix complanatae. Antherae caudato-sagittatae, appendicibus terminalibus triangularibus acuminatis, caudis liberis linearibus plusminusve acuminatis hirsutulis vel subglabris. Styli laevis rami mediocres vel longi erecti vel subpatentes glabri rotundati vel subtruncati.—Species typica *D. Tatei*, sp. nov.

In Hoffmann's arrangement of the genera of this tribe, which is an improvement on that of Bentham, *Duidaea* falls in the subtribe Mutisinae. Its only close relative is *Gongylolepis* Rob. Schomb., which was wrongly referred to *Stifftia* Mikan by Bentham, who has been followed by all subsequent authors. Bentham's error is difficult to understand, since *Stifftia* is a member of the subtribe *Gochnatinae*, characterized by the regularly 5-parted corollas (at least in the disk), while those of *Gongylolepis* were described by Schomburgk as bilabiate. Although not distinguished from *Gongylolepis*, of which three species are now known, by very strong structural characters, the three species of *Duidaea* differ decidedly from that genus in habit, with minor differences in involucre, receptacle, achenes, pappus, anthers, and style branches, and are best treated as constituting an independent genus. The leaves of *Duidaea* are narrowly linear or subacicular and 1-nerved, those of *Gongylolepis* broad, penninerved and strongly venose; the heads of *Duidaea* are solitary and pedunculate, those of *Gongylolepis* solitary and sessile or several and loosely corymbed; the involucre of *Duidaea* is composed of comparatively thin, scarcely more than stramineous or pergamentaceous, mostly acute or acuminate phyllaries, that of *Gongylolepis* of strongly coriaceous, very blunt phyllaries; the receptacle of *Duidaea* is scarcely alveolate, that of *Gongylolepis* is strongly so; the achenes of *Duidaea* are pubescent at apex or throughout and are nearly or quite destitute of pappiferous collar, while in *Gongylolepis* the achenes are glabrous or obscurely puberulous and the pappiferous collar is conspicuous; the pappus of *Duidaea* is more scanty and of less flattened bristles, although these differences are not entirely constant; the anther tails are free in *Duidaea*, connate in *Gongylolepis;* and the style branches are mostly rounded in *Duidaea*, mostly truncate and often obscurely lobate in *Gongylolepis*.[1]

[1] The genus *Duidaea*, all of whose species when sterile or only in bud give an impression of wiry stunted pine seedlings, is peculiar to the exposed plateau of Duida. *D. rubriceps*, seen first on Brocchinia Hills, occurred also where the southwest trail crossed ridges, but nowhere so abundantly as at Savana Hills. *D. Tatei* was found only in the rocky gorge of the Caño Negro, where it rooted in crevices in the jointed rock a little below high-water mark. *D. pinifolia* is much more aquatic, being abundant in the rocky bed of the brook at Central Camp, where it rooted in crevices as *D. Tatei*, but was invariably covered by even a small rise of the stream.—G.H.H.T.

Duidaea Tatei Blake, sp. nov. Frutex ramis infra denudatis glabratis, novellis densissime foliosis piloso-tomentosis; folia alterna lineari-acicularia 1-nervia marginibus valde revolutis juventute laxe tomentosa mox glabrescentia; capitula mediocria solitaria terminalia pedunculata folia subaequantia 9-flora homogama; involucri ca. 6-seriati gradati 1.5–1.8 cm. alti phyllaria substraminea acuminata ad obtusa striata laxe pilosa et ciliata; corollae bilabiatae 2 cm. longae; achenia apice hispidula.

Branches usually simple, often in threes, the older dark brown, smooth, glabrous, 2–4 mm. thick, the younger cross-ridged, finely tomentulose, those of the year densely and loosely pilose-tomentose with ochroleucous hairs; leaves very crowded, erect or spreading, at first loosely tomentose, at maturity glabrate or usually pilose on costa beneath; petioles about 1.5 mm. long, as

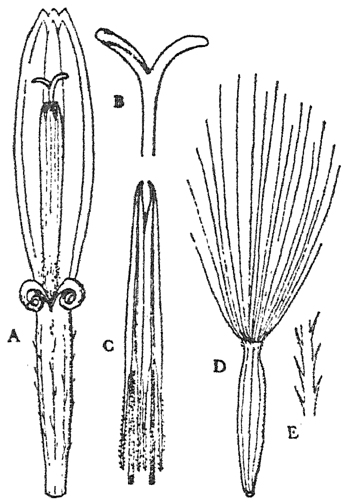


Fig. 8. *Duidaea Tatei.*

broad as the blade; blades 2.3–6.8 cm. long, 0.8–1.5 mm. wide, subulately callous-pointed, coriaceous, light or yellowish green, shining above, the margins often so strongly revolute as to conceal the costa; peduncles terminal or sometimes apparently axillary, 1.5–2 cm. long, slender, loosely pilose-tomentose, bearing near apex 2–3 triangular bracts about 2 mm. long; head (moistened) thick-cylindric, 2 cm. high, about 6 mm. thick, rounded at base; phyllaries about 24, whitish or brownish, often with reddish brown tips, the outer ones firmer, triangular or triangular-ovate, 2–6 mm. long, 1.5–2.5 mm. wide, the middle ones lance-oblong, acuminate to obtusish, 2.5–3.5 mm. wide, the innermost linear, acute to obtuse, 1.5–2.5 mm. wide, thinner and subscarious; receptacle densely hirsute; corollas apparently purplish, the tube 7 mm. long, hispidulous, the outer lip elliptic-oblong, 3-denticulate, 4-nerved, 12.5 mm. long, 3.5 mm. wide, the inner lip 2-parted, the segments strongly

revolute, linear-lanceolate, acuminate, 2-nerved, 0.5 mm. wide at base; achenes fusiform, plump, about 10-ribbed, 6 mm. long, brown, shining, sparsely hispidulous at apex, otherwise glabrous; pappus rather sparse, multiseriate, graduate, stramineous, 1 cm. long, the bristles scarcely flattened, not thickened at apex, hispidulous, the outermost only 1.5 mm. long; anthers 7 mm. long, the terminal appendages lanceolate, narrowed to an obtusish tip, 1 mm. long, the sacs 3 mm. long, the tails linear, 3 mm. long, acuminate, free, densely hirsutulous; style smooth, the branches oblong, widened above, spreading-ascending, rounded, glabrous, 1 mm. long (Pl. 42).

Fig. 8. A. Corolla ×5. B. Style-tip ×7.5. C. Anthers ×5. D. Achene ×5. E. Part of pappus-bristle ×20.

Gorge of Caño Negro, Savanna Hills, 4000 ft., *814*. Distinguished from *Duidaea pinifolia* Blake by its loosely and rather persistently pilose-to-mentose branches, its strongly revolute-margined leaves, its pilose-tomentose peduncles, and only apically pubescent achenes.

Duidaea pinifolia Blake, sp. nov. Frutex ramis infra denudatis, novellis densissime foliosis inter folia dense breviterque tomentosis cito glabratis; folia alterna confertissima angustissime linearia subacicularia glabra 1-nervia; capitula mediocria solitaria vel bina terminalia 9-flora homogama pedunculata, pedunculis folia subaequantibus; involucri ca. 5-seriati valde gradati ca. 1.6 cm. alti phyllaria substraminea acuminata ad acuta parce pilosiuscula et ciliata vel ciliolata; corollae 1.5 cm. longae bilabiatae; achenia dense hirsuta.

Shrub 0.6 m. high, the older branches glabrous, smooth, brownish, 2.5 mm. thick, the younger cross-ridged; short growth of the year purple-brown, densely and compactly ochroleucous-tomentose between the bases of the leaves, quickly glabrate; leaves 2.5–7.5 cm. long, 0.7–1 mm. wide, obtuse or acutish, essentially sessile, purplish-red toward base, above dark or light green, somewhat shining, with prominent sulcate costa, beneath light yellowish green, the whitish costa prominent, about half as broad as blade, and somewhat produced laterally so as to make the lower surface of leaf 2-sulcate; peduncles terminal or subterminal, 2.5–5 cm. long, slender, glabrous, bearing a few subulate bracts 3–8 mm. long; involucre (moistened) subcylindric, 5 mm. thick, the phyllaries few (about 18) appressed, substramineous in texture, usually tinged with purple-brown, obscurely striate, the outer triangular or triangular-ovate, acuminate, 3–6 mm. long, 1.5–3.5 mm. wide, the middle ones oblong, acute or acutish, 4 mm. wide, the innermost similar but thinner and subscarious, obtuse or acutish, all finely erose-ciliolate and with scanty deciduous crisped hairs on back and pilose ciliation; receptacle short-hirsute; corollas "white," 15 mm. long, the tube and base of outer lip outside crisped-pilosulous, the tube 6 mm. long, the outer lip oblong, 3-denticulate, 4-nerved, 9 mm. long, 2.5 mm. wide, the inner lip 2-parted, the segments linear-tri-

angular, acuminate, 0.6 mm. wide at base, strongly revolute; achenes somewhat fusiform, 10-ribbed, 6 mm. long; pappus straw-color, rather scanty, graduate, 1.2 cm. long, the bristles very slightly flattened, hispidulous, the outer 2 mm. long; anthers 6.3 mm. long, the terminal appendages triangular-ovate, obtusish, 1 mm. long, the sacs 3.5 mm. long, the tails linear, acutish, free, finely serrulate toward tip, 1.8 mm. long; style smooth, the branches linear-oblong, truncate or truncate-rounded, erect, glabrous, 1.5 mm. long.

Streambed at Central Camp, 4800 ft., *530*.

Duidaea rubriceps Blake, sp. nov. Frutex ramis infra denudatis ad apicem densissime foliosis et pilosis; folia alterna linearia acutiuscula coriacea 1-nervia infra 2-sulcata primum tomentosa maturitate supra vel utrinque glabrata; capitula magna solitaria terminalia pedunculata 21-flora homogama; involucri ca. 8-seriati valde gradati ca. 3.5 cm. alti phyllaria substraminea vel exteriora subcoriacea oblonga ad linearia acuta margine tomentoso-ciliolata; corollae 2.5 cm. longae bilabiatae; achenia sparse hirsutula.

"Brittle shrub, 1 m. high," sparsely branched, the branches sometimes flexuous, the older fuscous-brown, smooth, glabrous, 3–4 mm. thick, the younger densely cicatricose, ochroleucous-tomentulose, the youngest densely leafy and densely ochroleucous-pilose with straightish hairs; leaves very crowded at tips of branches, on petioles about 1 mm. long, the blades 2.5–4.5 cm. long, 2–4 mm. wide, subacute, at first loosely and somewhat floccosely grayish- or ochroleucous-tomentose on both sides, soon smooth and shining above with the costa impressed or obscure, beneath more persistently gray-tomentulose but finally glabrate, yellowish-green, thick-margined, shallowly 2-sulcate beneath with broad rounded costa; peduncles 2–2.5 cm. long, slender, tomentose, glabrescent, bearing several subulate acuminate bracts 12 mm. long or less; involucre (moistened) cylindric-campanulate, about 1.2 cm. thick, the phyllaries loosely appressed, mostly purplish-brown, tomentose-ciliolate or at length only obscurely ciliolate, glabrous dorsally, with evident costa and several more obscure nerves, the outer phyllaries triangular, acuminate, similar to the bracts of peduncle, 1–1.2 cm. long, about 2.5 mm. wide, the middle ones oblong, acuminate, 6–8 mm. wide, the innermost thinner, linear, 2–3.5 mm. wide; receptacle densely short-hirsute; corollas "red," 2.5 cm. long, the tube puberulous, 6 mm. long, the outer lip linear, 3-denticulate, 4-nerved, 19 mm. long, 2.8 mm. wide, the inner lip 2-parted, the segments narrowly linear-triangular, acuminate, strongly revolute, 2-nerved, 0.4 mm. wide at base; achenes fusiform-oblong, 6 mm. long, light brown, about 10-nerved, bearing a short pappiferous collar; pappus graduate, 1.5 cm. long, rather scanty, straw-color, the bristles scarcely flattened, hispidulous, the outermost 5 mm. long; anthers 15.5 mm. long, the terminal appendages triangular, acuminate to an obtuse apex, about 2 mm. long, the sacs about 7.5 mm. long, the tails 6 mm. long, narrowly linear, acuminate, free, retrorsely or irregularly short-hirsute; style smooth, the branches erect, linear, obtusely rounded, glabrous, 3 mm. long (Pl. 43).

Brocchinia Hills, 4500 ft., *589* (type); Savanna Hills, 4400 ft., *1042*. Distinguished from both the other species by its broader and thicker leaves and larger heads.

MUSCI[1]

Lowland species

OCTOBLEPHARUM ALBIDUM (L.) Hedw. On rock, top of Esmeralda Ridge, *226;* on living and dead trees at Middle Camp, *334*; Asia, Japan, Hawaii, and warmer parts of America.

OCTOBLEPHARUM AMPULLACEUM Mitt. Among rocks, top of Esmeralda Ridge, *225;* northern South America.

LEUCOBRYUM MARTIANUM (Hornsch.) Hampe. Among rocks, top of Esmeralda Ridge, *224;* on living and dead trees at Middle Camp, *333;* Foothills Camp, 750 ft., *1065;* West Indies and northern South America.

SYRRHOPODON BERNOULLII C. Müll. At Esmeralda, *1064;* Guadeloupe and Central America.

Drepanophyllum duidense Williams, sp. nov. Statura et habitu *D. fulvo* Rich arcte consimile sed recedit foliorum parte superiore lata plusminusve truncata duplicato-serrata.

Plants sterile, growing in quite compact, rather dull, greenish-brown cushions, with more or less branching stems radiculose below, up to 3 cm. high, and usually bearing on the stout apex of the stem a cluster of reddish propagula, about 100μ long, with 10–12 cross-walls and tapering slightly in both directions from near the middle; cross-sections of stem about 60μ in diameter, showing no central strand, the ground-tissue of large, thin-walled cells and outer walls composed of about three layers of smaller, thick-walled cells; leaves complanate, very unsymmetric, spreading-recurved to one side, the larger up to nearly 3 mm. long and 0.8 mm. wide near the apex, the base only about half as wide as above, the margins flat and entire, except at the rounded or truncate, doubly serrate apex; costa narrow at base and slightly tapering upward, mostly percurrent or nearly so, the leaf-blade on one side very narrow, often scarcely evident about halfway up and usually widest near the apex; cells of leaf mostly elongate-rhomboidal with somewhat thickened, pitted walls, the basal becoming much more elongate with thicker, more flexuous and pitted walls.

Pl. 44. 1. Plant about natural size. 2. Lower stem-leaf $\times$20. 3. Upper stem-leaf $\times$20. 4. Median cells of leaf $\times$275. 5. Apex of upper leaf $\times$35. 6. Apex of stem with propagula $\times$35. 7. Basal cells of leaf $\times$320. 8. Propagulum $\times$80. 9. Cross-section of stem $\times$160.

Among rocks, top of Esmeralda Ridge, *222*. Very different from the only other known species in the broad, truncate-serrate apex of the leaf.

[1] By R. S. Williams.

RHIZOGONIUM SPINIFORME (L.) Bruch. Foothills Camp, 750 ft., *1062;* southern United States and warmer regions of the world.

PILOSIUM FLACCISETUM C. Müll. Foothills Camp, 750 ft., *1063;* Guiana and Bolivia.

SEMATOPHYLLUM GALIPENSE (C. Müll.) Mitt. Among rocks, top of Esmeralda Ridge, *223;* at Foothills Camp, 750 ft., *1061;* West Indies to Paraguay.

Species of Mount Duida

SPHAGNUM CAPILLACEUM TENELLUM (Schimp.) Andrews. Top of Ridge 24, 6300 ft., *482;* on Peak 7, 7100 ft., *482a;* widely distributed in North and South America, Europe and Asia.

SPHAGNUM MAGELLANICUM Brid. Top of Ridge 24, 6300 ft., *483;* widely distributed in the Americas and the Old World.

CAMPYLOPUS PRAEALTUS (C. Müll.) Par. Top of Ridge 24, 6300 ft., *485;* on Peak 7, 7100 ft., *485a;* known from Rio Janeiro and Porto Rico.

OCTOBLEPHARUM ERECTIFOLIUM Mitt. Sides and bed of creek at Provisional Camp, 6300 ft., *571;* Jamaica and Costa Rica.

OCTOBLEPHARUM PULVINATUM (Dz. & Mb.) Mitt. Top of Ridge 24, 6300 ft., *488;* Central America, northern South America.

LEUCOBRYUM GIGANTEUM C. Müll. Sides and bed of Creek at Provisional Camp, 6300 ft., *507;* Central America, northern South America.

Carinafolium Williams, gen. nov.

Genus *Octoblepharo* arcte simile sed differt carina manifesta ad partem costae basalem pagina dorsale, chlorocystis plerumque 4-angulatis perparvis et ad paginam dorsalem saepissime proximioribus.

Glossy yellowish-white plants of medium size. Stems without rhizoids, often branching in the upper part, in cross-section showing cells of nearly uniform size, all except the outer row with somewhat thickened reddish walls, the walls of the outer row thinner and hyaline. Leaves and cells much like those of *Octoblepharum* in structure, but the costa with a distinct keel extending from near the base about one fourth up the leaf on the lower side; the mostly 4-angled chlorocysts very small and rather nearer the dorsal than the ventral side of the leaf.

Carinafolium Tatei Williams, sp. nov. Caulibus ochroleucis laxe caespitosis saepe ramosis, ca. 3 cm. altis, sectione transversale 5-gonis, reste centrale nulla, cellularum corticalium pallidarum strato unico obtectis; foliis erecto-patentibus, paullum flexuosis, fere linearibus; costae carina ad partem folii quartam extendente.

Flowers and fruit unknown; growing in compact, glossy, yellowish-white tufts with erect, unbranched or slightly branched stems about 3 cm. high;

stems in cross-section more or less pentagonal, 0.15–0.20 mm. in diameter, without central strand, the cells all with thickened red walls, except the outer layer in which the walls are quite thin and pale; leaves nearly linear, up to 5 mm. long, erect-spreading, often slightly flexuous, acutely pointed, flat in upper part, the larger ones somewhat concave below and bearing on the under side of the costa a little above its base a distinct keel about one fourth the entire length of the costa; cross-sections in lower part of leaf show two layers of leucocysts across the greater part of the leaf except at the margins and along the thickened middle, with mostly very small 4-angled chlorocysts usually a little nearer the dorsal than the ventral side; median leaf-cells more or less rectangular with very thin, minutely pitted walls, and pores rather indistinct and slightly oval; the marginal blade-cells often very narrow about halfway up the leaf and in 3–6 rows; the costa at base narrowed, with blade of 4 or 5 rather wide cells on each side.

Pl. 45. 1. Plant about natural size. 2. Larger stem-leaf, showing keel ×14. 3. Two smaller leaves, not keeled ×14. 4. Apex of larger leaf ×125. 5. Part of base of same ×125. 6. Median leaf-cells from lower side of leaf ×180. 7. Cross-section of leaf near upper end of keel ×180. 8. Cross-section near best developed part of keel ×180. 9. Cross-section of stem ×180.

Without definite locality, 5700 ft., *1054*. The distinct keel toward the base on the back of the costa in the upper leaves seems to be unique in the Leucobryaceae.

Macromitrium ulophyllum Mitt. On tree-trunk, High Point Camp, 6800 ft., *596;* northern South America.

Funaria calvescens Schwaegr. On burned ground, Burned Mountain, 6700 ft., *684;* widely distributed in Europe, Asia, Africa and temperate and tropical America.

Rhizogonium Lindigii (Hampe) Mitt. Sides and bed of creek at Provisional Camp, 6300 ft., *513;* central and northern South America.

Polytrichum antillarum Rich. On burned ground, Burned Mountain, 6700 ft., *683;* West Indies, Central America and northern South America.

Hypnella pilotrichelloides Broth. Sides and bed of creek at Provisional Camp, 6300 ft., *508;* also known from British Guiana.

Sematophyllum tequendamense (Hampe) Mitt. Near top of Peak 7, 7050 ft., *660;* Venezuela, Colombia, and Bolivia.

APPENDIX

Temperatures and weather on Mount Duida

Camp	Date	6 A.M.	2 P.M.	7 P.M.	Remarks
Foothills Camp	Nov. 15	79		81	
750 feet	" 16	76		79	Heavy rain during night.
" "	" 17	77		78	Day clear. Rain in evening.
" "	" 18	75			Showers in evening.
" "	" 19	75			
" "	" 20	73			Clear dry day and night.
" "	" 24	76		79	
" "	" 25	74		80	
Provisional Camp	" 27	63		67	
6300 feet	" 28	65		66	
" "	" 29	64		67	
" "	" 30	60	73	66	
" "	Dec. 1	54	76	68	
" "	" 2	62			
" "	" 7	58		62	
" "	" 8	62	67	63	
" "	" 9	59		64	
" "	" 10	59			
" "	" 11	61		63	
" "	" 12	61			
" "	" 13	62			
Central Camp	" 22	63		67	
4800 feet	" 23	62		68	
" "	" 24	64		67	
" "	" 25	63			
" "	" 26	63	72	66	
" "	" 27	59		68	
" "	" 28	63		67	Cloudy; showers at night.
" "	" 29	65		65	Rain all morning and night.
" "	" 30	64		64	Rain all morning; afternoon and evening clear.
" "	" 31	61	74	64	Night clear.
" "	Jan. 1	64	74	63	Heavy clouds during night; rain at 4 P.M.
" "	" 2	62		65	Morning clear. Rain in evening.
" "	" 3	56	75	64	Clear.
" "	" 4	61	71	64	Morning cloudy, clearing at 2 P.M. Rain in evening.
" "	" 5	64		66	Morning cloudy, clearing at 2 P.M. Rain in evening.

APPENDIX (*Continued*)

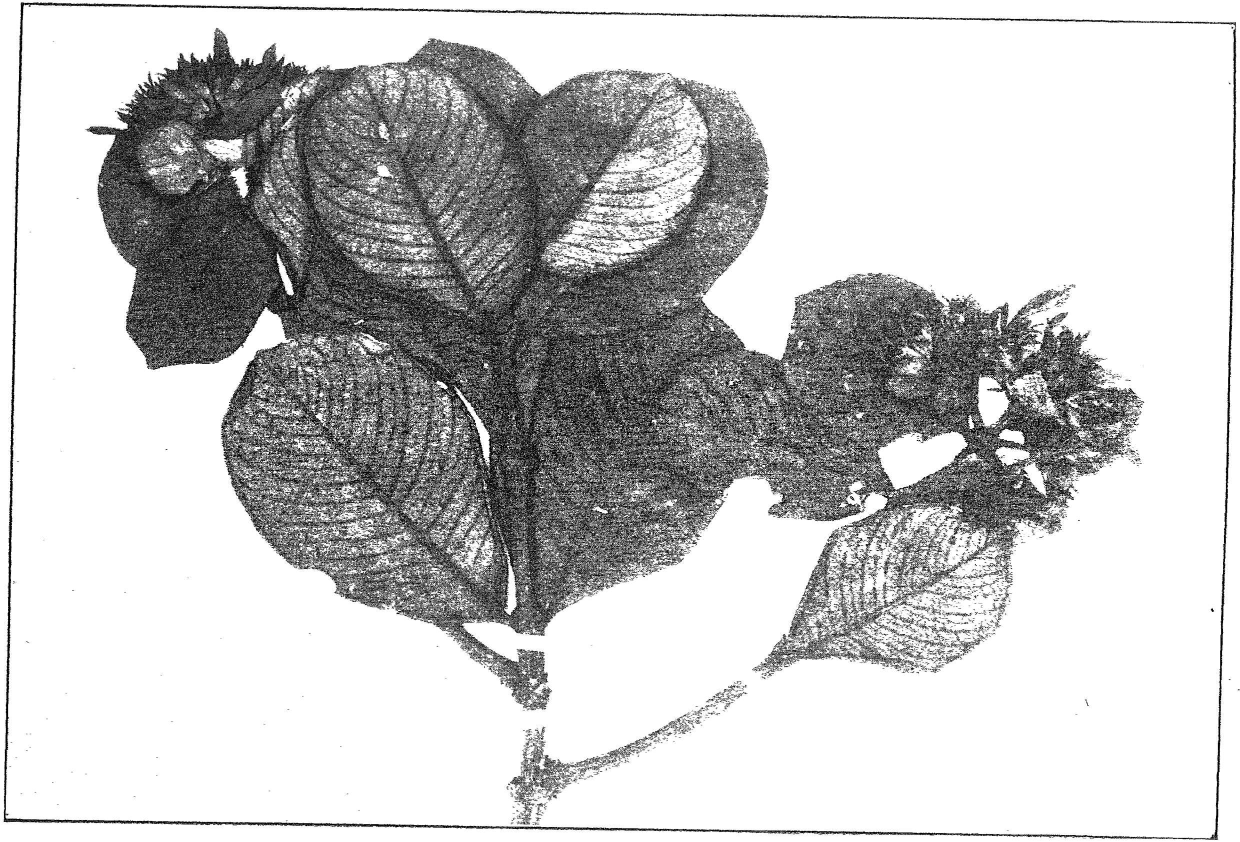
Temperatures and weather on Mount Duida

Camp	Date	6 A.M.	2 P.M.	7 P.M.	Remarks
" "	Jan. 6	64	78		Morning cloudy with heavy fog; afternoon clear.
" "	" 7	65		66	Morning cloudy; clear 2–5:30 P.M.; rain in evening.
" "	" 8	64		67	Morning cloudy; clear 2–5:30 P.M.; evening cloudy.
" "	" 9	63		64	Hazy.
Desfiladero	" 10	60		60	Clear only in early morning. Rain in P.M.
High Point 7100 feet	" 11	55		59	Clear only in early morning. Rain 6 P.M.
" "	" 12	57		62	Clear only in early morning. Night clear.
" "	" 13	56		62	Showers 4–8 P.M., clearing.
" "	" 14	53	58	62	Very clear in early morning; heavy fog during day.
" "	" 15	54	70	57	Very clear day. Strong northeast winds.
" "	" 16	56		60	Thick clouds and fog all day; clear in central valley.
" "	" 17	54		57	Early morning clear; cloudy, then clearing in P.M.
" "	" 18	54		58	Very clear day; night clear.
" "	" 19	54	68	62	Morning clear; rain in afternoon.
" "	" 20	56	72	58	Rain all day, clearing at 5:30 P.M.
" "	" 21	57	62	58	Early morning clear; clouds and light rain during day.
" "	" 22	57		58	Heavy clouds during day; strong NE. winds all night.
" "	" 23	56	65	59	Heavy clouds during day; strong NE. winds all night.
" "	" 24	58		60	Strong NE. wind with driving fog all day and evening; central valley clear.
" "	" 25	55		61	Intermittent cloud, increasing in P.M.
" "	" 26	54		61	Early morning clear, cloudy during day, clearing at 6 P.M., showers in central valley.
" "	" 27	58		61	Cloudy; light NE. wind with showers; central valley clear.
" "	" 28	56			Intermittent cloud all day; central valley clear.

APPENDIX (*Continued*)

Temperatures and weather on Mount Duida

Camp	Date	6 A.M.	2 P.M.	7 P.M.	Remarks
Agua Linda	Jan. 30	60		61	Clear at 6 A.M., clouded on scarp by 7 A.M.; clearing at 1:30 P.M.
" "	" 31	60		62	Heavy cloud to E. Thunderstorms in P.M. and night.
" "	Feb. 1	61		63	Heavy cloud, clearing at 4 P.M. Rain in evening; heavy rain at night.
" "	" 2	59		62	Morning very cloudy, clearing at 3 P.M.; Central Valley clear all day.
" "	" 3	60		63	Morning cloudy, light rain in P.M., clearing.
" "	" 4	57		60	Day and night clear and dry.
" "	" 5	54		60	Morning clear, clouding in P.M., night clear.
" "	" 6	56		62	Light NE. wind; showers in P.M., with increasing cloud.
" "	" 7	60		61	Rain all day, clearing in late P.M., night clear.
" "	" 8	57		62	Morning cloudy, rain 1–4 P.M., clearing.
" "	" 9	56		61	Clear all day and evening.
Savanna Hills	" 11		78	66	Day clear; heavy cloud to NE.
4500 feet	" 12	63		66	Thick cloud with rain from NE.; night clear.
" "	" 13	58		65	Morning clear; rain during night.
" "	" 14	61			Morning clear, clouding in P.M.; showers at 5:30; night clear.
" "	" 15	59			Morning clear; strong NE. wind and showers in late P.M.
" "	" 16	61			Morning cloudy, clearing.
" "	" 19	60		67	Morning clear, clouding at 4:30 P.M.; showers at 5 P.M. and all night.
" "	" 20	61	83	66	Clear day, strong NE. wind; rain at 4 P.M.
" "	" 21	62		65	Morning cloudy, clearing in P.M.; showers in evening, night clear.
" "	" 22	58			Fair all day.



DUIDANIA MONTANA $\times$ 3/4

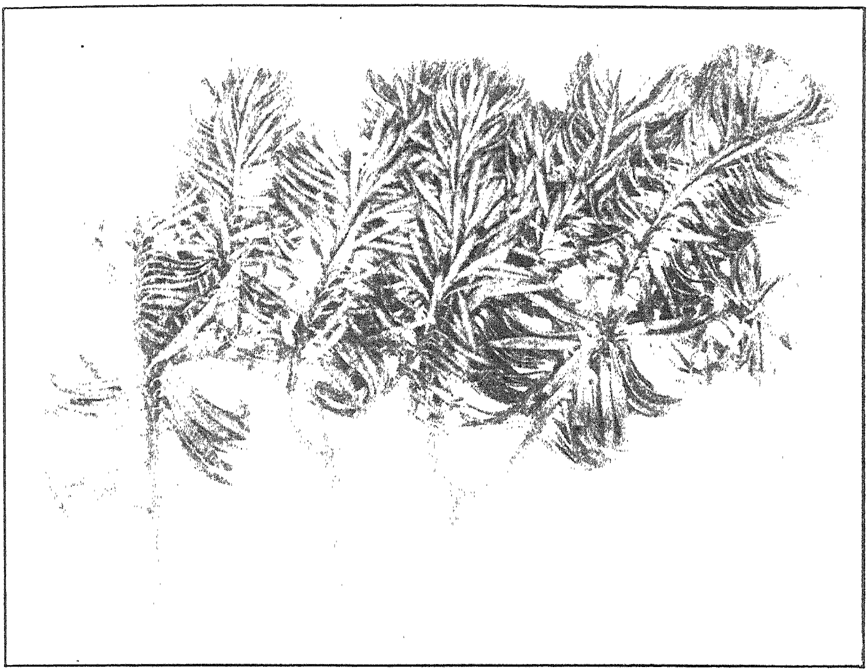


FIG. 1. TYLEROPAPPUS DICHOTOMUS

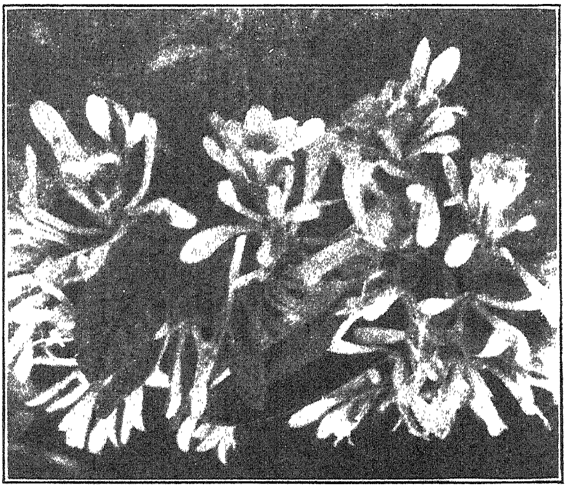
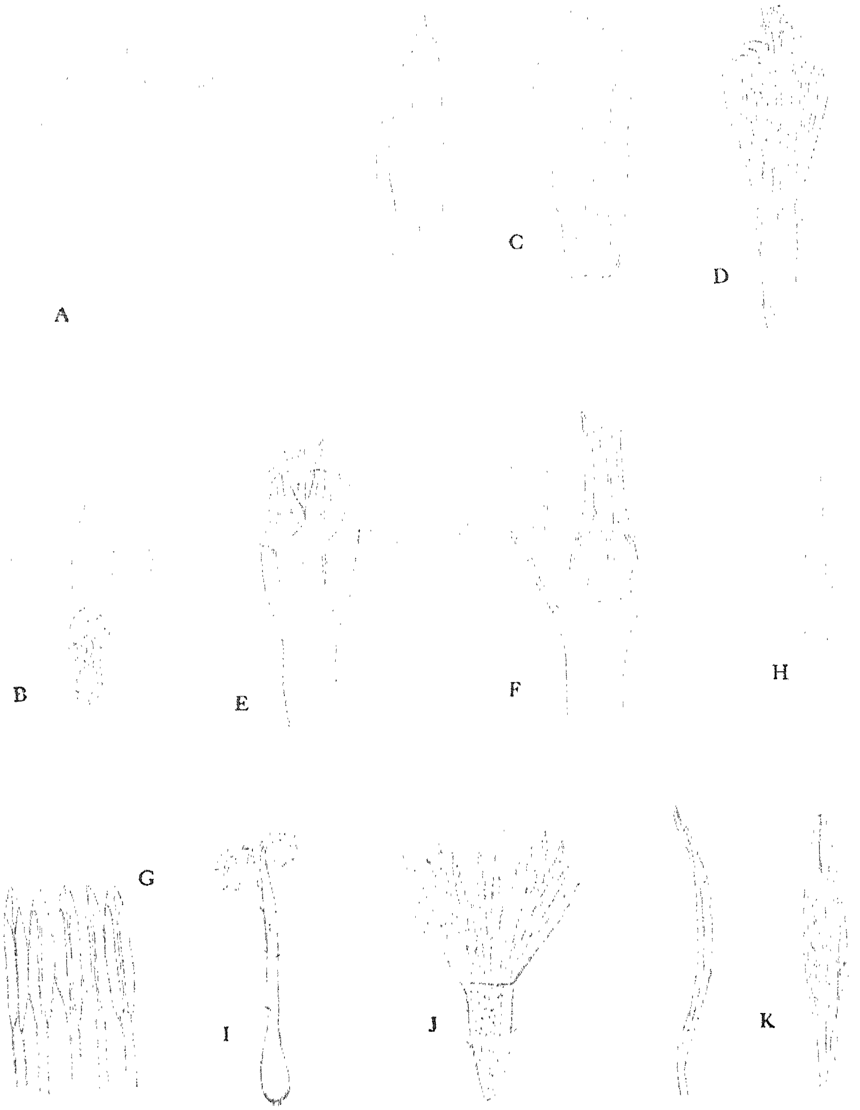
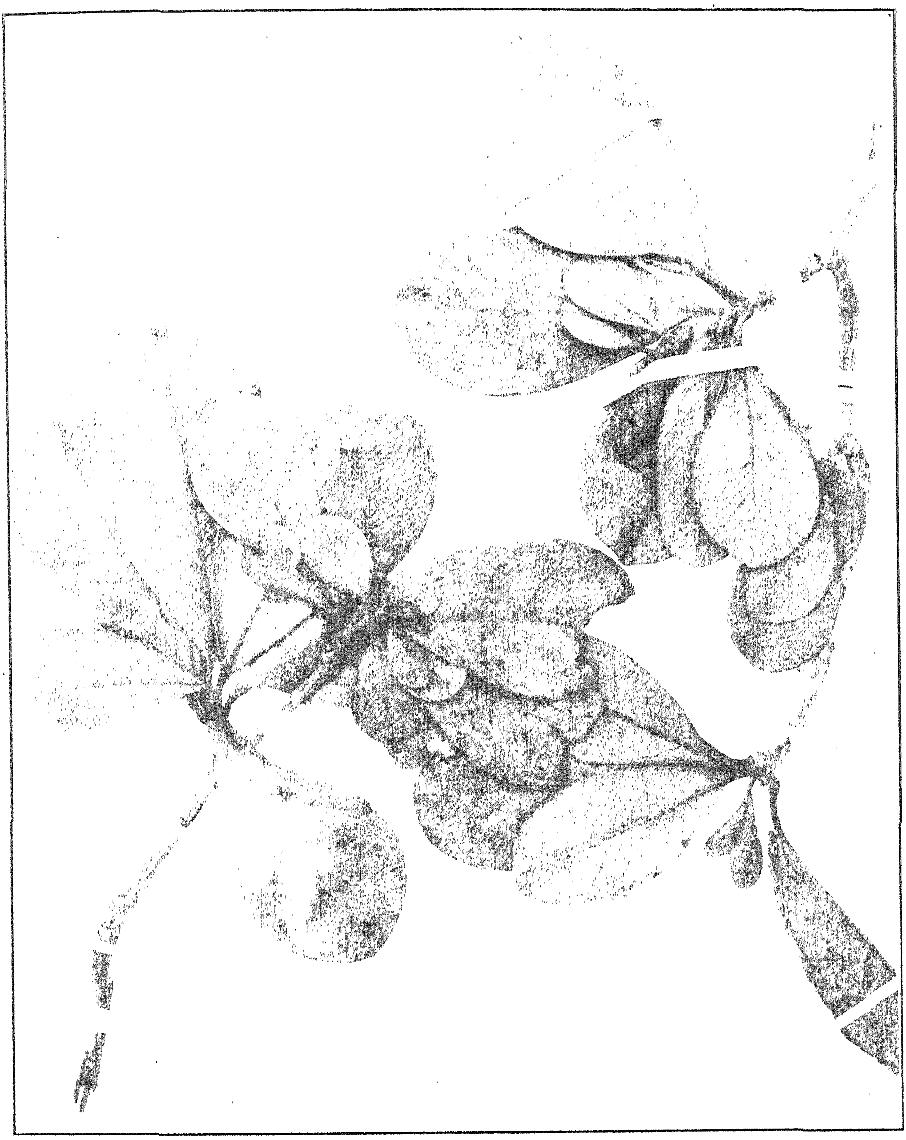


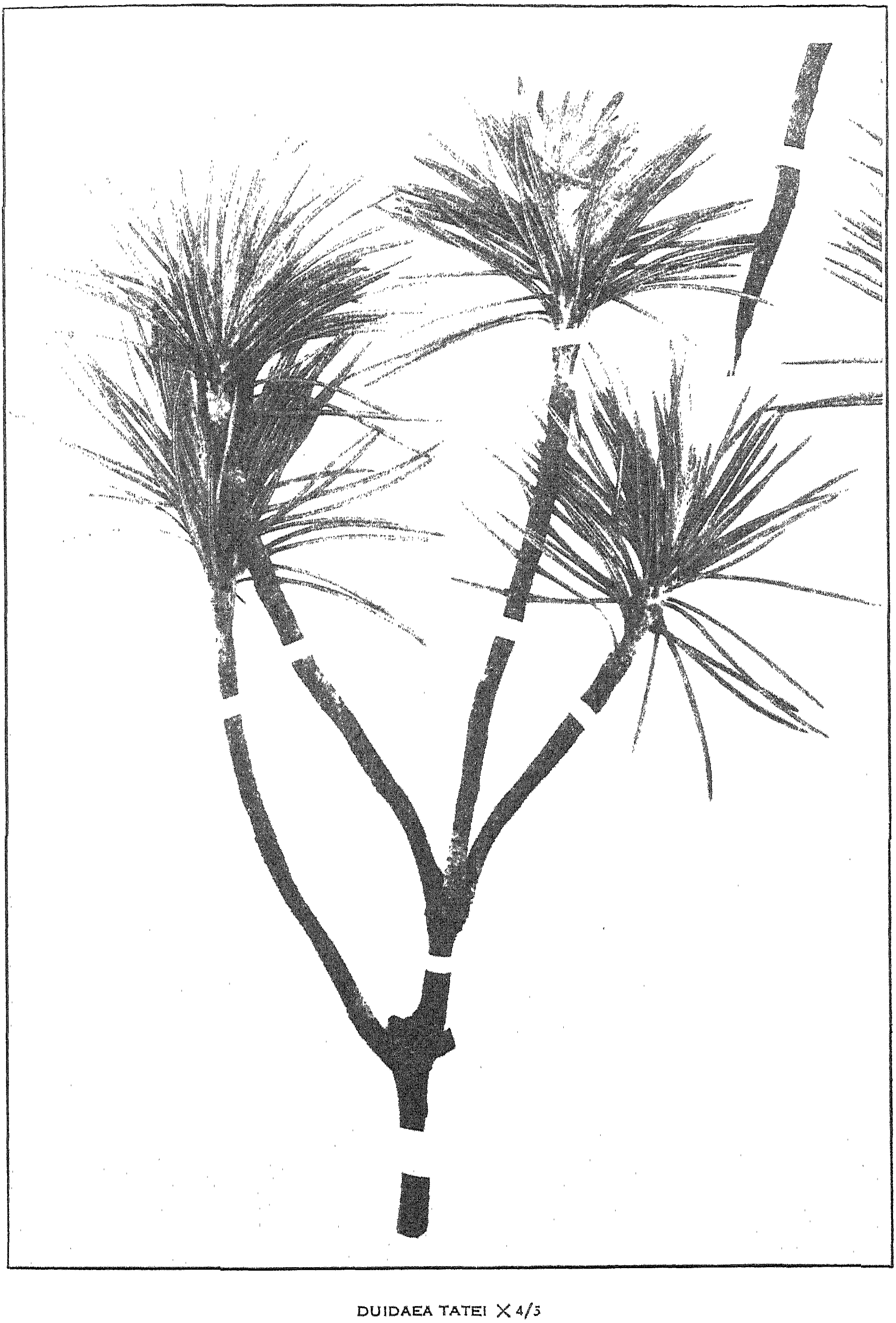
FIG. 2. GLEASONIA DUIDANA



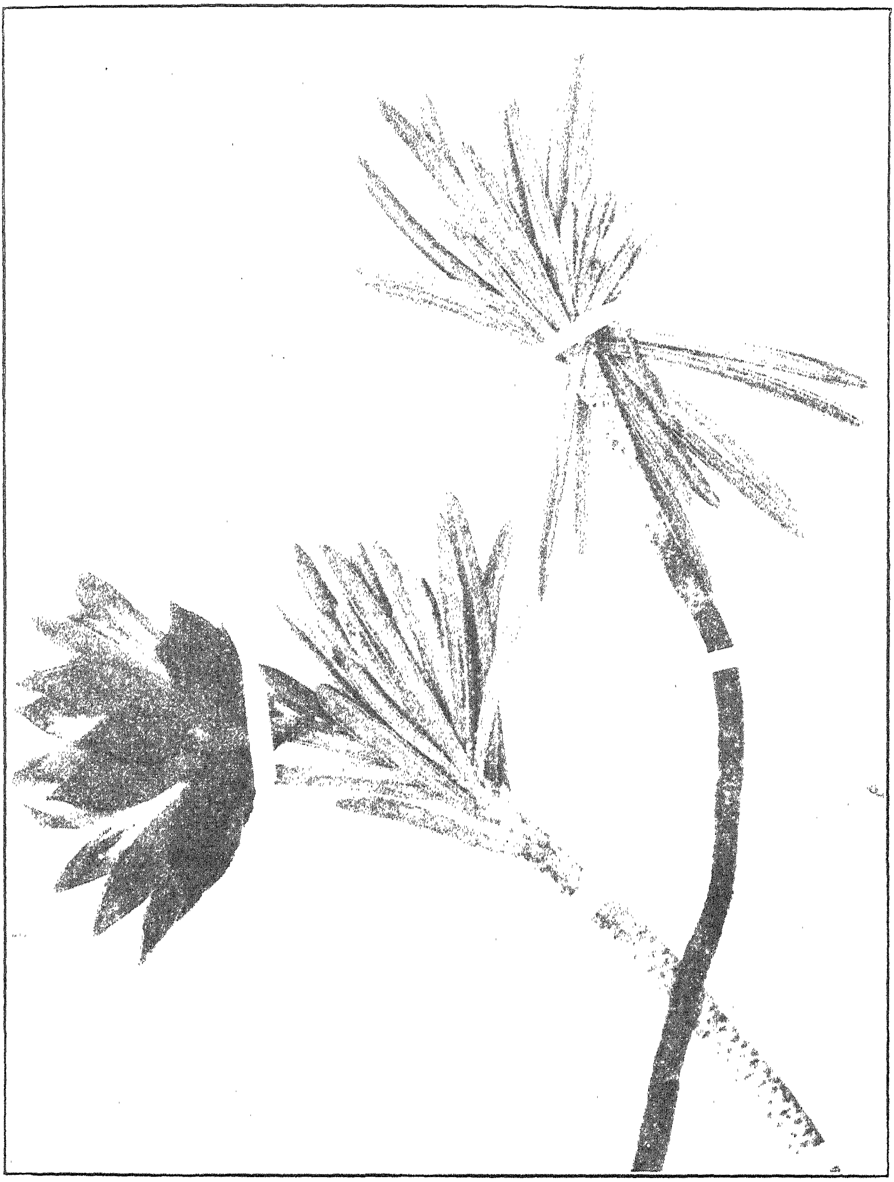
TYLEROPAPPUS DICHOTOMUS



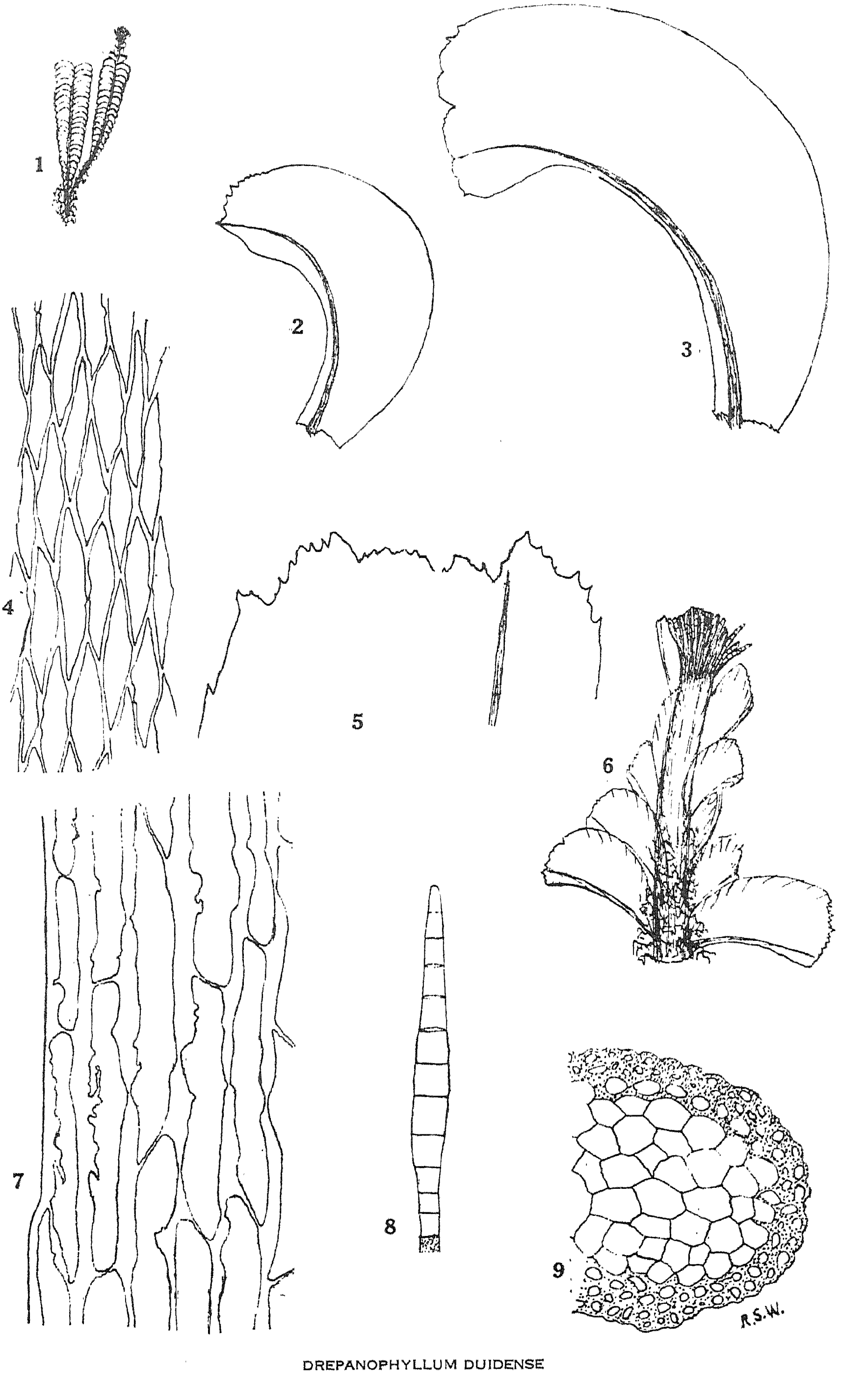
STENOPADUS TALAUMIFOLIUS × 1/2



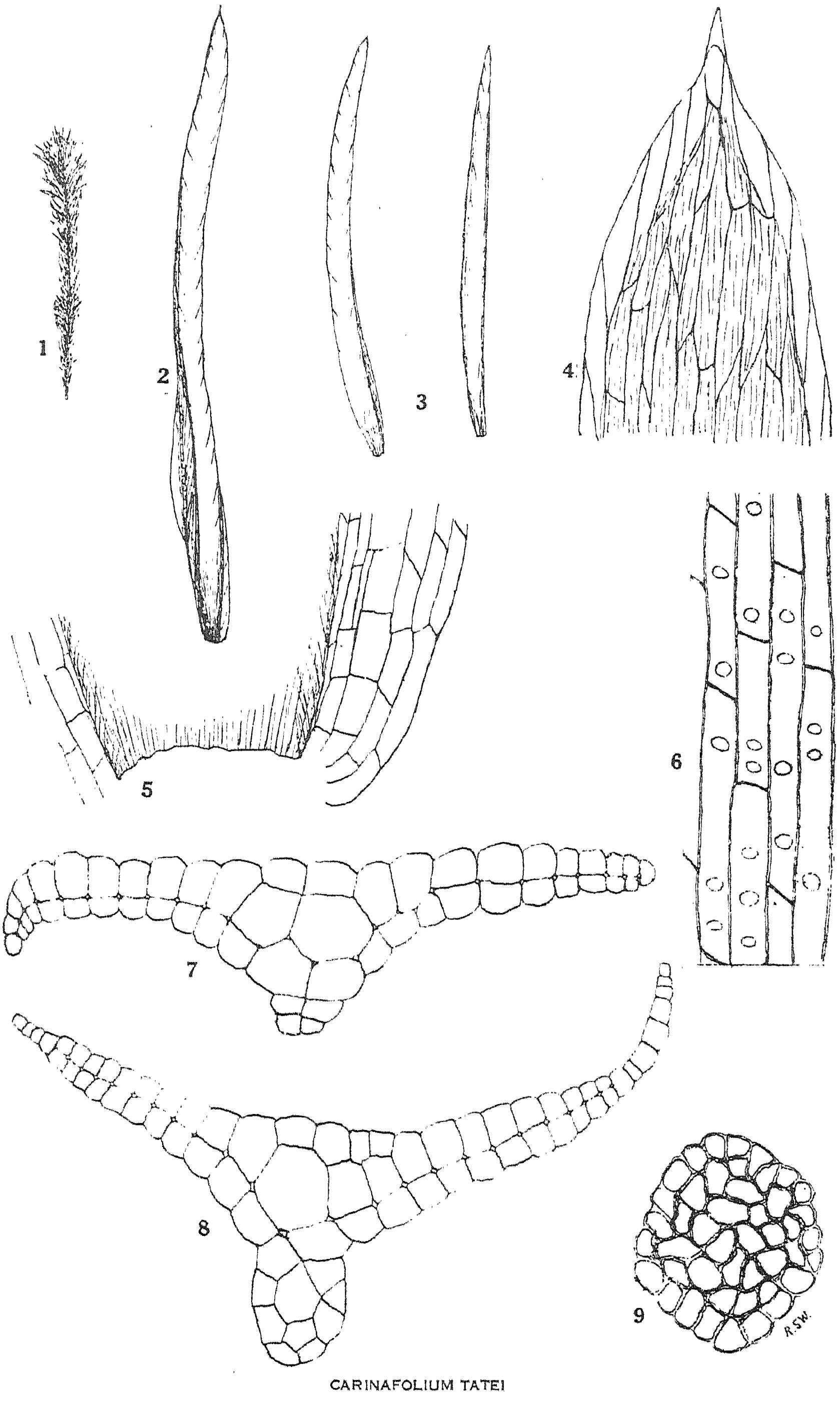
DUIDAEA TATEI × 4/5



DUIDAEA RUBRICEPS



DREPANOPHYLLUM DUIDENSE



CARINAFOLIUM TATEI

INDEX TO AMERICAN BOTANICAL LITERATURE
1927–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Ames, O. An addition to the flora of Honduras. Proc. Biol. Soc. Washington **44:** 43–44. 22 My 1931.

Ames, O. A new species of *Pleurothallis* from Central America. Proc. Biol. Soc. Washington **44:** 41, 42. 12 My 1931.

Anderson, W. A. A list of Tennessee ferns. Am. Fern Jour. **20:** 143–150. 26 D 1930; **21:** 11–20. "Ja-Mr" 6 Ap 1931; 64–71. 20 Je 1931.

Andrus, C. F. The mechanism of sex in *Uromyces appendiculatus* and *U. Vignae.* Jour. Agr. Res. **42:** 559–587. *f. 1–11.* 1 My 1931.

Armstrong, G. M., & Albert, W. B. A study of the cotton plant with especial reference to its nitrogen content. Jour. Agr. Res. **42:** 689–703. *f. 1–3.* 15 My 1931.

Baird, V. B. Collecting trips of Ezra Brainerd in California. Madrono **1:** 185–186. S 1928.

Bamford, R., & Gershoy, A. Studies in North American violets. II. The cytology of some sterile F_1 violet hybrids. Vermont Agr. Exp. Sta. Bull. 325: 1–53. *pl. 1—22.* "D 1930" Ap 1931.

Bartholomew, E. T. Herbarium arrangement of mycological specimens. Mycologia **23:** 227–244. *pl. 21, 22+f. 1–4.* 1 My 1931.

Bates, C. G., & Roeser, J. Jr. Light intensities required for growth of coniferous seedlings. Am. Jour. Bot. **15:** 185–194. *f. 1.* 27 Mr 1928.

Baxter, E. M. A new species of *Neomammillaria.* Jour. Cactus & Succ. Soc. Am. **2:** 471–472. *illust.* My 1931.

Neomammillaria phitauiana Baxter.

Beck, W. A. Variations in the Og of plant tissues. Plant Physiol. **6:** 315–323. *f. 1–4.* Ap 1931.

Blakeslee, A. F. The genetic view-point. Science II. **73:** 571–577. 29 My 1931.

Blinks, L. R., & Blinks, A. H. Two genera of algae new to Ber-

muda. Bull. Torrey Club **57**: *389–396. pl. 22, 23+f. 18.* "Je 1930" 20 Je 1931.

Bödeker, F. *Mamillaria balsasensis* Böd. spec. nov. Monats. Deutsch. Kakteen-Gesell. **3**: 121–122. *illust.* My 1931.

A plant from Mexico.

Bogusch, E. R. A new variety of *Koeberlinia.* Torreya **31**: 73–74. *f. 1.* My-Je 1931.

Brade, A. C. A Saporema *Polyporus sapurema* Möll. Bol. Mus. Nac. Rio de Janeiro **6**: 303–305. *f. 1–3.* D 1930.

Breakey, E. W., & Walker, R. I. Preliminary reports on the flora of Wisconsin. XII. Polypodiaceae. Trans. Wisconsin Acad. Sci. **26**: 263–273. *f. 1–30.* 1931.

Bryan, M. K. Additional data on the range and prevalence of lima-bean scab. Phytopathology **21**: 559. My 1931.

Burr, G. O. Native vegetation in the pre-historic Lake Bonneville basin. Jour. Am. Soc. Agron. **23**: 407–413. My 1931.

Bush, B. F. Francis Daniels' grasses. Am. Midl. Nat. **12**: 343–362. My 1931.

Butler, M. R. Comparison of the chemical composition of some marine algae. Plant. Physiol. **6**: 295–305. Ap 1931.

Camp, W. H. The grass balds of the Great Smoky Mountains of Tennessee and North Carolina. Ohio Jour. Sci. **31**: 157–164. *f. 1, 2.* My 1931.

Campbell, D. H. The Australasian element in the Hawaiian flora. Am. Jour. Bot. **15**: 215–221. 28 Mr 1928.

Card, H. H. A revision of the genus *Frasera.* Ann. Missouri Bot. Gard. **18**: 245–282. *pl. 14, 15+f. 1–4.* Ap 1931.

Caron, O. *Anacharis* vs. *Elodea canadensis.* Nat. Canadien **58**: 113–114. My 1931.

Castellanos, A. Bromeliaceae Argentinae novae vel criticae. II. An. Mus. Nac. Hist. Nat. Buenos Aires **36**: 49–57. *pl. 1–15;* III. 369–375. *pl. 1–7.* F 1931.

Cattell, W. The effects of x-rays on the growth of wheat seedlings. Science II. **73**: 531–533. *illust.* 15 My 1931.

Chester, K. S. Graft-blight of lilac. Arnold Arbor. Bull. Pop. Inf. **5**: 5–8. *illust.* 2 My 1931.

Chupp, C. Cercosporae. In Chardon & Toro, Mycological Exploration of Colombia. Jour. Dep. Agr. Porto Rico **14**: 282–296. O 1930.

Chardonia gen. nov. and three new species are described.

Ciferri, R. Smuts collected in the Dominican Republic by E. L. Ekman. I. Ark. Bot. **23A**[14]: 1–29. *pl. 1–3+f. 1, 2.* 26 My 1931.

Ciferri, R. Quinta contribuzione allo studio degli Ustilaginales. Ann. Myc. **29**: 1–74. *f. 1–17*. 1931.

Clausen, J. Chromosome number and relationship of some North American species of *Viola*. Ann. Bot. **43**: 741–764. *f. 1–60*. O 1929.

Cool, M. T. La rona de la toronja en Puerto Rico. Porto Rico Agr. Exp. Sta. Circ. 92: 1–15. *f. 1–3*. 1931.

Cook, O. F. Inequality of cotton fibers. Jour. Heredity **22**: 25–34. *f. 11–14*. Ja 1931.

Cooper, D. C. Microsporogenesis in *Buginvillaea glabra*. Am. Jour. Bot. **18**: 337–358. *pl. 22–26*. 27 My 1931.

Costello, D. F. Comparative study of river bluff succession on the Iowa and Nebraska sides of the Missouri River. Bot. Gaz. **91**: 295–307. *f. 1–6*. 15 My 1931.

Costello, D. F. Preliminary reports on the flora of Wisconsin. XIII. Fagaceae. Trans. Wisconsin Acad. Sci. **26**: 277–279. 1931.

Coulter, J. M. Development of botany in the United States. Proc. Am. Philos. Soc. **66**: 309–318. 1927.

Crozier, W. J., & Navez, A. E. Temperature characteristic for production of CO_2 by *Phaseolus* seedlings. Jour. Gen. Physiol. **14**: 617–629. *f. 1–5*. 20 My 1931.

Currence, T. M. A new pod color in snap beans. Jour. Heredity **22**: 21–23. *f. 10*. Ja 1931.

Dana, B. F. Soil cultures for the laboratory production of sclerotia in *Phymatotrichum omnivorum*. Phytopathology **21**: 551–556. *f. 1, 2*. My 1931.

Dana, B. F., & Wolff, S. E. The occurrence of violet root rot in central Texas. Phytopathology **21**: 557–558. *f. 1*. My 1931.

Davies, P. A. Distribution of total nitrogen in regeneration of the willow. Bot. Gaz. **91**: 320–326. *f. 1–5*. 15 My 1931.

Davis, B. M. Lamarck's evening primrose (*Oenothera Lamarckiana* Seringe) was a form of *Oenothera grandiflora* Solander. Proc. Am. Philos. Soc. **66**: 319–355. 1927.

Davis, J. J. Notes on parasitic fungi in Wisconsin. XVIII. Trans. Wisconsin Acad. Sci. **26**: 253–261. 1931.

Davis, W. H. Anthracnose, Alternariose and *Botrytis* rot of the snowberry. Mycologia **23**: 159–190. *pl. 15–19*+*f. 1–5*. 1 My 1931.

Diels, L. Anonaceae novae. Notizbl. Bot. Gart. Berlin **11**:73–86. 31 Mr 1931.

Many South American species are described as new.

Dodge, B. O. Studies in the genus *Gymnosporangium*. V. A de-

structive red-cedar rust disease. Jour. N. Y. Bot. Gard. **32:** 101–108. *f. 1–3.* My 1931.

Donat, A. Contribuciones al conocimiento la flora de la Patagonia oriental. La flora de la region Costanera. Darwiniana **2:** 58–71. 31 D 1930.

Dunlap, A. A. Carbohydrate variations accompanying the mosaic disease of tobacco. Am. Jour. Bot. **18:** 328–336. 27 My 1931.

Eisenmenger, W. S. Factors modifying the toxicity of phenol. Plant Physiol. **6:** 325–332. *f. 1.* Ap 1931.

Ewer, S. J. Botanical explorations at Katahdin. Maine Nat. **10:** 87–98. *illust.* 1930.

Fawcett, H. S. The importance of investigations on the effects of known mixtures of microorganisms. Phytopathology **21:** 545–550. My 1931.

Felippone, F. Plantas nuevas en la flora Uruguaya. Fauna y Flora Uruguay **1:** 1–8. *f. 1.* 1925.

Frenguelli, J. Contribuciones al conocimiento de las Diatomeas argentinas: VI, Diatomeas marinas de la Costa Atlantica de Miramar. An. Mus. Nac. Hist. Nat. Buenos Aires **36:** 243–311. *pl. 1–10+f. 1–8.* 29 Au 1930.

Frick, G. A. *Echinofossulocactus* plants in the garden of Mrs. Wright, Santa Barbara. Jour. Cactus & Succ. Soc. Am. **2:** 480–481. *illust.* My 1931.

Frick, G. A. *Cephalocereus senilis.* Jour. Cactus & Succ. Soc. Am. **2:** 470. *illust.* My 1931.

Frick, G. A. *Euphorbia neriifolia.* Jour. Cactus & Succ. Soc. Am. **2:** 468–469 *illust.* My 1931.

Garner, W. W., & Allard, H. A. Effect of abnormally long and short alternations of light and darkness on growth and development of plants. Jour. Agr. Res. **42:** 629–651. *f. 1–6.* 15 My 1931.

Gilg, E. Über eine Gattung der Ochnaceae (?) *Alloiosepalum*, aus Peru. Notizbl. Bot. Gart. Berlin **11:** 97–99. *f. 3.* 31 Mr 1931.

Gleason, H. A. Scientific expedition to Venezuela. Jour. N. Y. Bot. Gard. **32:** 108–113. My 1931.

Goodman, G. J. Notes on the distribution of some Rocky Mountain plants. Ann. Missouri Bot. Gard. **18:** 283–286. *f. 1.* Ap 1931.

Griscom, L. Another station for *Panicum calliphyllum* Ashe. Rhodora **33:** 131–132. 8 My 1931.

Guillaumin, A. Les plantes grasses du Mexique. La Terre et La Vie II. **1:** 90–98. *illust.* 1931.

Guiscafre, J. R. Gomosis de la Toronja en la Hacienda Eugenia, Pto. Rico. Rev. Obr. Publ. Puerto Rico **8:** 124–125. *f. 1–6.* My 1931.

Gyelnik, V. Notes on *Peltigera.* Bryologist **34:** 16–19. "Mr" 15 Je 1931.

Includes descriptions of two new species.

Hamilton, J. M. Studies of the fungicidal action of certain dusts and sprays in the control of apple scab. Phytopathology **21:** 445–523. *f. 1–7.* My 1931.

Harms, H. Eine neue Gattung der Flacourtiaceae. Notizbl. Bot. Gart. Berlin **11:** 146–149. *f. 4.* 31 Mr 1931.

Harned, J. E. Wild flowers of the Alleghanies. i-xxxii, 1–670. *illust.* Oakland, Md., 1931.

Harper, F. Some plants of the Athabaska and Great Slave Lake region. Canadian Field Nat. **45:** 97–107. *f. 1–3.* 1 My 1931.

Harrison, G. J. Metaxenia in cotton. Jour. Agr. Res. **42:** 521–544. *f. 1–4.* 1 My 1931.

Hartman, M. E. Antheridial dehiscence in the Polypodiaceae. Bot. Gaz. **91:** 252–276. *f. 1–27.* 15 My 1931.

Harvey, E. M. A method for studying water conduction in plants in relation to pruning, grafting and other horticultural practices. Oregon Agr. Exp. Sta. Bull. 279: 1–26. *f. 1–8.* My 1931.

Hastings, G. T. A wild flower pilgrimage. Torreya **31:** 75–76. My-Je 1931.

Herter, G. Estudios botanicos en la region Uruguaya. IV. Florula Uruguayensis plantae vasculares. 1–191. *illust.* Montevideo, 1930.

Hoar, C. S. Meiosis in *Hypericum punctatum* Lam. Science II. **73:** 528–529. 15 My 1931.

Houghton, A. D. *Echinocereus Davisii* sp. nov. Jour. Cactus & Succ. Soc. Am. **2:** 466. *illust.* My 1931.

Howe, M. D. A morphological study of the leaf notches of *Bryophyllum calycinum.* Am. Jour. Bot. **18:** 387–390. *pl. 31.* 27 My 1931.

Huskins, C. L. The origin of *Spartina Townsendii.* Genetica **12:** 531–538. *f. 1–6.* 1930.

Also published in Nature **127:** 781. 23 My 1931.

Jackson, H. S. Ustilaginales. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Porto Rico **14:** 296–300. O 1930.

Jenkins, A. E. Development of the *Citrus*-scab organism, *Sphaceloma Fawcettii.* Jour. Agr. Res. **42:** 545–558. *pl. 1+f. 1–5.* 1 My 1931.

Jenkins, A. E. *Gloeosporium rosae*, a nomen nudum. Mycologia **23**: 223–224. 1 My 1931.

Jepson, W. L. Biological peculiarities of Californian flowering plants I. Madrono **1**: 190–192. *f. 1, 2*. N 1928.

Jepson, W. L. The botanical explorers of California I. Madrono **1**: 167–170. *illust.* Mr 1928; II. 175–177. *illust.* Je 1928; III. 183–185. *illust.* S 1928; IV. 188–190. *illust.* N 1928; V. 214–216. *illust.* Jl 1929; VI. 262–270. *illust.* D 1929.

Jepson, W. L. *Sequoia sempervivens* in Granada. Madrono **1**: 242. S 1929.

Johansen, D. A. Endotrophic mycorrhiza in Cacti. Jour. Cactus & Succ. Soc. Am. **2**: 478–480. *f. 1–6*. My 1931.

Johansen, D. A. The hypostase and seed sterility in the Onagraceae. Madrono **1**: 165–167. Mr 1928.

Johnson, A. M. Taxonomy of the flowering plants. i-xxi, 1–864. *f. 1–478*. New York, Century Co., 1931.

Johnston, C. O., & Mains, E. B. Relative susceptibility of varieties of sorghum to rust, *Puccinia purpurea*. Phytopathology **21**: 525–543. *f. 1–7*. My 1931.

Johnston, E. S., Brackett, F. S., & Hoover, W. H. Relation of phototropism to the wave-length of light. Plant Physiol. **6**: 307–313. *f. 1, 2*. Ap 1931.

Jones, J. P. The diagnostic value of plant symptoms in determining nutrient deficiencies of soils. Jour. Am. Soc. Agron. **23**: 352–356. My 1931.

Keller, G. E. The blazing star of the Niagara Gorge. Hobbies **2**: 242–243. My 1931.

Kelso, L. A new *Castilleja* from Colorado. Madrono **1**: 241–242. S 1929.

Kern, F. D., & Whetzel, H. H. Uredinales. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Porto Rico **14**: 301–348. O 1930.

Seven new species in various genera are described.

Kertesz, Z. I. Discharge of saccharase from mycelium of *Penicillium glaucum*. Plant Physiol. **6**: 249–264. *pl. 8+f. 1, 2*. Ap 1931.

Li, H. W. Heritable characters in maize. XXXVII. Brevis. Jour. Heredity **22**: 14–16. *f. 8*. Ja 1931.

Lammerts, W. E. Interspecific hybridization in *Nicotiana*. XII. The amphidiploid *rustica-paniculata* hybrid; its origin and cyto-genetic behavior. Genetics **16**: 191–211. *f. 1–10*. My 1931.

Lane, G. H. A preliminary pollen analysis of the East McCulloch peat bed. Ohio Jour. Sci. **31**: 165–171. *f. 1, 2*. My 1931.

Langdon, L. M. Development and vascular organization of the foliar organs of *Carya cordiformis*. Bot. Gaz. **91**: 277–294. *pl. 1, 2+f. 25–28.* 15 My 1931.

Lauritzen, J. I. Some effects of chilling temperatures on sweet-potatoes. Jour. Agr. Res. **42**: 617–627. *pl. 1.* 15 My 1931.

Leith, B. D., & Shands, R. G. The production of an economic strain of white barbless barley. Jour. Am. Soc. Agron. **23**: 396–401. My 1931.

Lemée, A. Dictionaire descriptif et synonymique des genres de plantes. Phanérogames. Vol. 3. i-xxxx, 1–1084. 1931.

Loesener, T. Über die Zingiberaceen des Herb. Ruiz und Pavon. Notizbl. Bot. Gart. Berlin **11**: 87–92. 31 Mr 1931.

Loesener, T. Was ist *Izquierdia* Ruiz et Pav.? Notizbl. Bot. Gart. Berlin **11**: 93–96. 31 Mr 1931.

Loomis, W. E. A quantitative demonstration of osmotic equilibrium. Plant Physiol. **6**: 365–367. *illust.* Ap 1931.

Macbride, J. F. Spermatophytes, mostly Peruvian. II. Rev. Univ. Cuzco **20**: 84–91. Jl 1931; III. Field Mus. Nat. Hist. Bot. Publ. **11**: 1–35. 29 My 1931.

McClure, F. A. A brief historical survey of the Lingnan University Herbarium. Lingnan Sci. Jour. **7**: 267–290. *pl. 12.* "Je 1929" Mr 1931.

McLaughlin, W. T. Preliminary reports on the flora of Wisconsin. XIV. Hyperiaceae. Trans. Wisconsin Acad. Sci. **26**: 281–288. *f. 1–12.* 1931.

McLean, F. T. Inheritance and chromosome number in the *Gladiolus*. Torreya **31**: 65–70. My–Je 1931.

McNair, G. T. Comparative anatomy within the genus *Euonymus*. Univ. Kansas Sci. Bull. **19**: 221–260. *pl. 22–27.* Jl 1930.

Malme, G. O. A. N. *Hieracea* brasiliensia. Ark. Bot. **23A**[15]: 1–10. *pl. 1, 2.* 15 My 1931.

Marquand, C. V. B. A biological holiday in the eastern Alps. Bryologist **34**: 23–26. "Mr" 15 Je 1931.

Mason, H. L. Additions to the flora of California. Madrono **1**: 187–188. N 1928.

Matsuura, H. Genic analysis in *Avena*. Jour. Sci. Hokkaido Imp. Univ. V. **1**: 77–107. Ap 1931.

May, C., & Gravatt, G. F. The Dutch elm disease. U. S. Dep. Agr. Circ. 170: 1–10. *f. 1–6.* My 1931.

Meinecke, E. P. Forest tree diseases and their control. Jour. Forest. **29**: 688–695. My 1931.

Melchior, H. Die Scropulariaceen-Gattungen *Orthocarpus* und *Castilleja* in Südamerika. Notizbl. Bot. Gart. Berlin **11**: 111–123. 31 Mr 1931.

Merrill, E. D. The California Botanic Garden. Madrono **1**: 163–164. Mr 1928.

Merrill, E. D. The local resident's opportunity for productive work in the biological sciences in China. Lingnan Sci. Jour. **7**: 293–296. "Je 1929" Mr 1931.

Merrill, E. D. Unrecorded plants from Kwangtung Province, II. Lingnan Sci. Jour. **7**: 297–326. "Je 1929" Mr 1931.

Twenty new species in various genera are described.

Mildbraed, J. Plantae Tessmannianae peruvianae. VIII. Notizbl. Bot. Gart. Berlin **11**: 135–146. 31 Mr 1931.

Millan, A. R. Solanáceas Argentinas clave para la determinación de los géneros. Bol. Min. Agr. Nac. Argentina **30**: 3–21. *f. 1–7*. Mr. 1931.

Miller, J. H. Xylariaceae. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Porto Rico **14**: 271–275. O 1930.

Molfino, J. F. Notas botanicas. VII. An. Soc. Cien Argentina **6**: 367–384. *illust.* Je 1931.

Montgomery, C. E. Ecology of the mosses of Grand de Tour region of Illinois, with special reference to pH relations. Bot. Gaz. **91**: 225–251. 15 My 1931.

Muenscher, W. C. Myxomycetes. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Puerto Rico **14**: 214–215. O 1930.

Mulay, A. S. Statistical study of the total nitrogen in Bartlett pear shoots. Plant Physiol. **6**: 333–338. *f. 1–5*. Ap 1931.

Munz, P. A. Studies in Onagraceae. VI. The subgenus Anogra of the genus *Oenothera*. Am. Jour. Bot. **18**: 309–327. 27 My 1931.

Neller, J. R. Is electrodialysis useful in a study of apple tissue? Plant Physiol. **6**: 355–359. *f. 1*. Ap 1931.

Neller, J. R. Relation of catalase activity to physiological breakdown in Jonathan apples. Plant Physiol. **6**: 347–354. *f. 1, 2*. Ap 1931.

Osterhout, W. J. V., & Hill, S. E. The production and inhibition of action currents by alcohol. Jour. Gen. Physiol. **14**: 611–616. *f. 1–3*. 20 My 1931.

Overholts, L. O. Eu-basidiomycetes. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Porto Rico **14**: 348–354. O 1930.

Pampanini, R. Plantae Sinenses a Dre. H. Smith 1921–22 lectae. Meddel. Göteborgs Bot. Trad. **6**: 67–78. 1930.

Perkins, A. E. Some unusual plants of Erie County. Hobbies **2**: 206–211. *illust.* Ap 1931.

Perry, L. M. The vascular flora of St. Paul Island, Nova Scotia. Rhodora **33**: 105–126. *illust.* 8 My 1931.

Petersen, N. F. Vegetative propagation in the Missouri gourd. Science II. 73: 528. 15 My 1931.

Pilger, R. Eine neue Art von Boopis aus Südbrasilien. Notizbl. Bot. Gart. Berlin **11**: 101–102. 31 Mr 1931.

Pittier, H. Note on *Escallonia tortuosa* H. B. K. Trop. Woods. **26**: 11–12. 1 Je 1931.

Porterfield, W. M. A review of the literature of the growth of bamboo. Lingnan Sci. Jour. **7**: 327–336. "Je 1929" Mr 1931.

Puttemans, A. Uma ferrugem nova em planta australiana cultivada no Brasil. Bol. Mus. Nac. Rio de Janeiro **6**: 311–314. *illust.* D 1930.

Ramaley, F. Growth of plants under continuous light. Science II. **73**: 566–567. 22 My 1931.

Reade, J. M. *Vaccinium Ashei* sp. nov. Torreya **31**: 71–72. My-Je 1931.

Record, S. J. West African avodiré (*Turraeanthus africana*). Trop. Woods **26**: 1–9. 1 Je 1931.

Reinking, O. A., & Humphrey, C. J. Laboratory tests on the durability of Philippine woods against fungi. Philippine Jour. Sci. **45**: 77–91. *pl. 1, 2.* My 1931.

Roberts, C. M. *Leucobryum albidum* for West Virginia. Bryologist **34**: 22. "Mr" 15 Je 1931.

Roscoe, M. V. The algae of St. Paul Island. Rhodora **33**: 127–131. *pl. 208+f. 1.* 8 My 1931.

Roush, E. M. F. A monograph of the genus *Sidalcea*. Ann. Missouri Bot. Gard. **18**: 117–244. *pl. 5–13.* Ap 1931.

Roy, H. Peuplements forestiers et végétation sous-bois. Nat. Canadien **58**: 105–112. My 1931.

Ruiz, L. F. Datos para la agrostologia Argentina y valor nutritivo de algunas gramineas forrajeras. Bol. Min. Agr. Nac. Argentina **30**: 49–69. *illust.* Mr 1931.

Rydberg, P. A. Notes on Fabaceae—XII. Bull. Torrey Club **56**: 539–554. "D 1929" 18 F 1930; XIII. Bull. Torrey Club **57**: 397–407. "Je 1930" 20 Je 1931.

Sampaio, A. J. de. A nomenclatura botanica e o methodo de typos. Bol. Mus. Nac. Rio de Janeiro **6**: 149–188. S 1930.

Sampaio, A. J. de. Phytogeographia do Brasil. Bol. Mus. Nac. Rio de Janeiro **6**: 271–299. *map.* D 1930.

Sandwith, N. Y. Contributions to the flora of tropical America. VI. New and noteworthy species from British Guiana, Dilleniaceae-Connaraceae. Kew Bull. Misc. Inf. **1931**: 170–

188. 1931; VII. New and noteworthy Leguminosae and Rosaceae from British Guiana. 357–377. 1931.

Sax, K. Plant hybrids. Arnold Arbor. Bull. Pop. Inf. **5**: 17–20. *illust.* 15 My 1931.

Seaver, F. J. Pezizales. In Chardon & Toro, Mycological exploration of Colombia. Jour. Dep. Agr. Porto Rico **14**: 225–227. O 1930

Belanopsis Ingae sp. nov. is described.

Shear, G. M. Studies on inanition in *Arachis* and *Phaseolus.* Plant Physiol. **6**: 277–294. *f. 1–4.* Ap 1931.

Skottsberg, C. Einige Pflanzen von der Oster-Insel. Meddel. Göteborgs Bot. Trad. **3**: 163–165. 22 D 1927.

Skottsberg, C. Notes on some recent collections made in the Islands of Juan Fernandez. Meddel. Göteborgs Bot. Trad. **4**: 155–171. *f. 1–17.* 23 Ja 1931.

Skottsberg, C. Remarks on the flora of the high Hawaiian volcanoes. Meddel. Göteborgs Bot. Trad. **6**: 47–65. 1930.

Skuja, H. Einiges zur Kenntnis der Brasilianischen Batrachospermen. Hedwigia **71**: 78–87. *pl. 1, 2.* My 1931.

Slavin, A. D. Notes on new forms of *Malus* and *Crataegus.* Am. Midl. Nat. **12**: 363–366. My 1931.

Small, J. K. The water-lilies of the United States. Jour. N. Y. Bot. Gard. **32**: 117–121. *f. 1–4.* My 1931.

Smith, G. M. Notes on the Volvocales. I–IV. Bull. Torrey Club **57**: 359–370. *pl. 17, 18.* "Je 1930" 20 Je 1931.

Three new species in *Eudorina* are described.

Smith, L. L. W., & Smith, O. Light and the carotinoid content of certain fruits and vegetables. Plant Physiol. **6**: 265–275. Ap 1931.

Sommer, A. L. Copper as an essential for plant growth. Plant Physiol. **6**: 339–345. *f. 1–3.* Ap 1931.

Sparrow, F. K. Jr. Observations on *Pythium dictyosporum.* Mycologia **23**: 191–203. *pl. 20+f. 1.* 1 My 1931.

Standley, P. C. *Talisia floresii*, a new fruit tree from Yucatan. Trop. Woods **26**: 14–15. 1 Je 1931.

Stearms, M. Alpines of the Simplon Kulme Pass. Gard. Chron. Am. **35**: 175. My 1931.

Stevens, F. L. A comparative study of *Sclerotium Rolfsii* and *Sclerotium Delphinii.* Mycologia **23**: 204–222. *f. 1–16.* 1 My 1931.

Stevens, F. L. Parasitic fungi of Peru and Ecuador. Ann. Myc. **29**: 102–106. *f. 1–3.* 1931.

Includes descriptions of one new genus and of five new species.

Heterothallism and hypothetical hormones in Neurospora

B. O. Dodge

(WITH A TEXT FIGURE)

There is a controversy of many years standing among mycologists as to whether in such forms as *Pyronema* and the Erysiphaceae an act of fertilization precedes the formation of ascocarps. Professor and Madame Moreau[1] have recently questioned the possibility of such a process at the origin of perithecia in species of *Neurospora*. In a more recent preliminary note, Moreau and Moruzi[2] have described an interesting culture experiment in which the U-tube plays an important rôle. It is claimed that their results further support the doctrine of the absence of a copulation at the origin of the ascocarp. The U-tube is a familiar piece of apparatus to students of physics and chemistry, and it is often used in experiments with bacteria and yeasts where the evolution of gases is being studied. Its use in an attempt to settle the puzzling questions of sexuality and heterothallism in the fungi is something new.

THE MOREAU-MORUZI U-TUBE EXPERIMENT

The culture tube was provided with two arms *M* and *N* of large diameter, while the median connecting portion was of smaller diameter (fig. 1). The culture medium was corn meal agar, upon which species of *Neurospora* fruit abundantly when mated. The experiment was carried out with two races of *Neurospora*. The race sowed in arm *M* was an orange-colored *Monilia* mold found in mushroom beds. It appeared to be the *Monilia* stage of a species of *Neurospora*. The race sowed in arm *N* was a strain of *N. sitophila* obtained from the writer. They had previously proved that these two races, sowed separately, produced only little sclerotia, but sowed together in the same Petri dish culture they produced perithecia with asci and ascospores. After some days ('au bout de quelques jours') small sclerotia were formed in each branch *M* and *N*, and then fertile perithecia developed, but only in the arm *M*. At first it was thought that the mycelium from the arm *N* had grown down around to mix with that in arm *M*. This was proved not to be the case in the following way.

As soon as perithecia appeared in *M* a section 'a–b' of the median portion of the tube was cut out and placed in a sterile damp chamber. The arm ends *M* and *N* were also placed in sterile containers. No growth ever

[1] Moreau, Fernand, et Mme. Moreau. Le développement du périthèce chez quelques Ascomycètes. Rev. Gén. Bot. **42**: 65–98. 1930.

[2] Moreau, Fernand, et Mlle. C. Moruzi. Recherches expérimentales sur la formation des périthèces chez les "*Neurospora*." Compt. Rend. Acad. Sci. Paris **192**: 1476–1478. 8 June 1931.

[The Bulletin for November (**58**: 465–516) was issued 24 December 1931.]

appeared in the section 'a–b'. After some days hyphae with conidia developed at the freshly cut ends of the *M* and *N* pieces. Conidia from these two sources were sowed separately, but the cultures developed no perithecia. Sowed together in the same Petri dish, perithecia with asci matured. This would seem to prove that the race cultured at *M* was not hermaphroditic. The characters of the asci and spores produced would have determined this point more certainly, but these details are not given.

Since it was proved that no hyphae passed from *N* to *M*, these authors conclude that there can be no act of copulation at the origin of the perithecium. There must be something developed analogous to hormones ('harmozones') which, diffusing through the agar in advance of the mycelial growth, induces the incipient perithecia in *M*, represented by sclerotia, to continue on to mature perithecia. Heterothallism in *Neurospora*, then, they conclude, is nothing more than a matter of diffusible hormones. The real act of fecundation occurs when two nuclei fuse in the ascus.

SOME GENERAL CONSIDERATIONS

We are all modifying our old notions as to the nature of sex in animals and higher plants. While using the terms sex and sexuality for convenience in describing the phenomena attending reproduction in *Neurospora* and *Ascobolus*, the writer has tried to avoid expressing himself very definitely on this question, being more content to learn what really happens, or what kinds of progeny are produced, when two different races or species are grown together in a culture. He has frequently pointed out that perithecium-like bodies are often produced in single spore cultures of the heterothallic species of *Neurospora*. From what we know of other ascomycetes it would not be surprising to find that these structures could be stimulated to produce asci under some particular conditions. When in the past, however, such bodies have been crushed the central region has always been found to be composed of a mass of empty cells. If asci develop in single spore cultures it must be a rare occurrence.

When the unisexual components, S_1 and S_6, of the hermaphroditic species *Neurospora tetrasperma* are grown from opposite sides of a Petri dish culture, perithecia are usually formed only on the S_6 side. Although it has not been possible to demonstrate clearly that hyphae from the side S_1 pass over onto the S_6 area it has always been obvious[3] that in some way the elements of inheritance from S_1 must be brought to each point where perithecia are formed on S_6. Not having any cytological proof, one might well hesitate before suggesting that, starting with anastomoses between hyphae

[3] DODGE, B. O. Material for demonstrating sexuality in the ascomycetes. Torreya **30**: 35–39. 1930.

of S_1 and S_6, there might be a wandering of nuclei from the S_1 hyphae back through the S_6 hyphae to account for the peculiar distribution of fruit bodies in such cultures[4].

Culturing the eight progeny from a single ascus will convince anyone that whatever it is that enables one mycelium so to influence another that perithecia will mature asci, it must be something that is associated with chromosomes in order to be segregated out at reduction in such a perfect Mendelian ratio. To carry out the idea of Moreau and Moruzi a little farther, may it not be that the genes for the Mendelian inheritance of morphological characters are also diffusible hormones? If one would grow a typical orange-colored conidial race of *Neurospora sitophila* in one arm which we may call arm $+C$ of our U-tube (fig. 1), and an albino non-conidial race of the opposite sex in the other arm $-C$, what kind of perithecia, if any, may one expect to obtain in the $+C$ arm, and what kind, if any, in the $-C$ arm?

RESULTS OF OUR OWN U-TUBE EXPERIMENTS

With the above question in mind, a number of U-tube experiments were carried out. For this purpose some of the tubes were patterned after the one described by Moreau and Moruzi. Others were more nearly V-shaped, and still others were of all sorts of shapes and sizes. The culture medium employed was corn meal agar varying in hardness up to 2 per cent. In some cases a corn meal decoction was first poured in to fill the median cross arm of the U-tube, and then corn meal agar was carefully poured in to harden on top of this. A corn meal gelatin medium was also tried out, but the gelatin is quickly liquified by *Neurospora*, and it is not a favorable medium for the production of perithecia even in mixed cultures.

The races of *N. sitophila* cultured were all derived from ascus no. 56, which was discussed in the paper previously cited[4]. By growing an orange-colored conidial race, either 56.7 or 56.8, in one arm, and an albino non-conidial race, either 56.1 or 56.2, in the other arm one had in his U–tube two mycelia which could be easily distinguished and which were of opposite sex. The reciprocal relationship was obtained when the albino non-conidial race, either 56.5 or 56.6, was grown in one arm and the orange-colored conidial race, either 56.3 or 56.4, in the other arm. Fifty such U–tube cultures, inoculated with the one or the other of these combinations, were prepared and kept under observation, in many cases for two or three months. Twelve U–tube cultures inoculated with the races S_1 and S_6

[4] See plate 7, figs. 15, 17 in DODGE, B. O. The inheritance of the albinistic non-conidial characters in interspecific hybrids in *Neurospora*. Mycologia 22: 265–334. 1931.

of *N. tetrasperma* were also grown for a long time.[5]

The experiment was varied by growing strains 56.8 and 56.1 separately in flasks containing corn meal broth for five or six days. During this time the same strains were grown separately on corn meal agar in ordinary culture tubes. The broth now presumed to contain the hormones was put through a Berkefeld filter, grade *N*, and some of the filtrate was introduced into the tube cultures. The customary checks were maintained. The particular filtrate introduced in each case was chosen with due regard to the sex of the mycelium in the culture tube, the filtrate from flask 56.8 going into tubes 56.1, and filtrate 56.1 into tubes 56.8. Thirty such cultures were prepared. Another set was made using strains S_1 and S_6.[5]

Mycelia that had been grown on broth were killed by steaming and then placed in plate cultures in which a mycelium of the opposite sex in each case had been growing for one week. This was done on the theory that dead fungous cells would give off the hormones as has been claimed for the higher plants.

The results of these experiments, so far as confirming the hormone theory of heterothallism in *Neurospora* proposed by Moreau and Moruzi is concerned, were entirely negative. As long as the two living mycelia do not meet in the presence of air, no perithecia are formed. Soon after the inoculations are made, hyphae begin to grow downward at a rate that seems to depend on how much absorbed air remains in the agar after sterilization. If the U–tube is dry-sterilized previously and the agar medium that has been held in tubes for some days is melted and poured into the U–tube, less oxygen is driven off. The hyphae from the opposite arms then usually grow downward rapidly, slowing up when about to meet somewhere along the median connecting arm (fig. 1, left). It is unnecessary to cut out a piece of the median portion of the tube to prove that the mycelia do not pass each other. With properly prepared agar one can see what goes on with a hand lens. Very few anastomoses occur between hyphae from the two sides in the absence of free air even though their end branches may intermingle somewhat. When two strains of opposite sex are grown in Petri dish cultures, one sees many anastomoses where the hyphal branches meet. In case most of the air has been boiled out of the agar through autoclaving or intermittent sterilization after the U–tubes have been filled, the hyphae do not grow downward very far, so there is apt to remain several centimeters of agar in the connecting arm entirely free from hyphae, even though the culture has been kept two or three months. If the medium in only one arm of the U–tube is inoculated, the mycelium grows down and around rapidly, and soon appears at the surface of the medium in the

[5] Later on these experiments were repeated varying the conditions somewhat, but with the same results in every case.

other arm, where conidia will be formed if it is conidial strain. When the medium in both arms has been inoculated, the mycelium present in one arm seems to prevent absolutely any hyphae in the other arm from growing around up in this fashion. No conidia, for example, have ever developed in the arm originally containing the $-C$ mycelium. Any ascocarps, then, that would be formed on the surface of the medium in either arm would have to be due either to the stimulus of something analogous to diffusible hormones, or to the wandering of nuclei brought into the unisexual mycelium as the result of anastomoses where the two mycelia of opposite sex

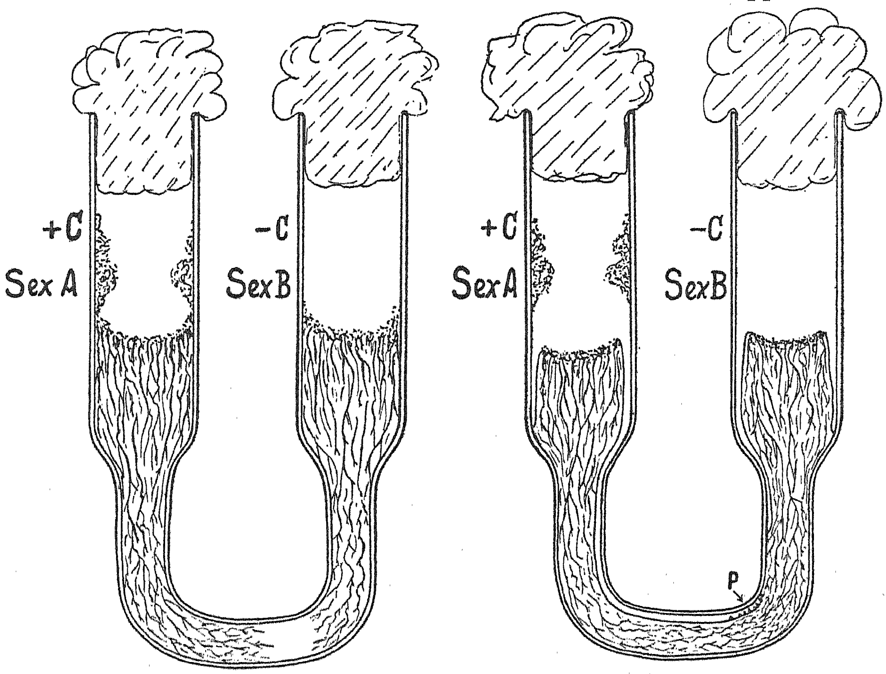


Fig. 1. Diagram of a section of one type of U-tube used. The position reached by the mycelia at the end of the first week is shown in the figure at the left. No further advance was apparent during the next eleven weeks. The figure at the right shows the air pockets due to drying of the agar during this time. Perithecia formed at P a few days after the air film reached this point.

may perhaps meet in the median connecting arm. No such perithecia have ever matured at the surface of the medium in either arm of our U-tubes. The explanation is clear from what follows.

After two or three weeks the agar in the side arms exposed to air usually begins to dry out and pull away from the glass (fig. 1, right). The hyphae that had ceased to grow downward then renew growth, keeping a little in advance of the layer of air that slowly makes its way down the side arms. This drying out usually occurs first in the arm containing the

conidial strain, perhaps because the production of masses of dry powdery conidia favors transpiration. In a U–tube of the pattern described by Moreau and Moruzi with a median arm of smaller diameter this drying out and pulling away of the agar does not extend into the connecting arm until after several weeks. The length of time depends upon the depth of the agar in the large side arms. It should be noted however that no perithecia are formed in any case until the drying out brings into the air pocket the mycelia of both sexes. Within a few days after this occurs perithecia always do form, but not at the top of the agar slant in the side arms. They first appear in the region down below where there is now an intermingling of the two mycelia in the presence of air (fig. 1, right). Perithecia may later form beneath the agar surface.

Five V–tubes were cut at the angle at the time when the two mycelia were about one centimeter apart at that point. The separated arms were kept in a sterile humid condition for two months without the formation of any perithecia. On the theory that hormones, by the laws of diffusion, would be distributed all through the agar, perithecia should have formed at the freshly broken surfaces a few days after exposure to air. In each case however, hyphae grew out and formed little sclerotia, but no perithecia ever matured, either at the freshly cut ends or at the surface of the original agar slants above in the large arms.

Whatever may be the rate at which the hypothetical hormones diffuse through agar media such as used here, as compared with the normal rate of growth of the mycelium under favorable conditions, by varying the amount of absorbed air and the amount of the agar medium in the U–tube one can so regulate the rate of growth as to enable any hormones given off by the mycelium at the surface of the medium in one arm of the tube to move downward faster than the hyphae. In some of our U–tubes hyphae from the two mycelia grew down so rapidly as to come within a few millimeters of each other within four or five days. In others the mycelia remained far apart for many weeks, or until the agar, by drying, pulled away from the glass and allowed air pockets to descend, thus providing oxygen for further growth. No matter whether the agar was so soft as to slide in the tubes when tilted, or whether it was comparatively hard (2 per cent), perithecia always matured a few days after the two mycelia came into contact in the presence of air. All the evidence obtained by the writer goes to show that without this contact between two mycelia of opposite sex, perithecia are not produced, and those hypothetical diffusible hormones, if any are produced by the strains of *Neurospora sitophila* and *N. tetrasperma* cultured, are not potent to induce the formation of perithecia with asci in U–tube cultures such as were described by Moreau and Moruzi.

THE NEW YORK BOTANICAL GARDEN

The genus Cinchona in Bolivia

H. H. Rusby

The most and best of our knowledge of the Bolivian cinchonas has been gained from a study of the living plants under cultivation in Bolivia and the Indies, and from that of the commercial products of these and the wild-growing trees. An important result of this study has been to demonstrate the incompleteness and insufficiency of taxonomic evidence supplied solely by the study of ordinary herbarium material. It is doubtful if any other genus of equal size has received such thorough study, as to gross and microscopical structure, chemistry, reproduction, embryology, horticulture, ecology and geography, as has *Cinchona*. It is remarkable to how great an extent the deductions from these several lines of study have been found mutually confirmatory, and the most of this evidence has been secured by a study of the trees under cultivation and by that of the commerce in the barks and their products.

In the early part of the year 1886, I devoted a number of weeks to the study of these trees in Mapiri, Bolivia, and in Yungas in 1885, and became familiar with their culture over many square miles of the Andean slopes. The very large collections then made were carefully studied as to their genetic origin as well as their individual characters, economics, and history. These specimens included ample herbarium material, four-foot quills of trunk bark—taken in each case from the same tree that yielded the herbarium material bearing the respective number—and wood-sections. Careful records were made and published in regard to the specimens, together with an account of culture, commerce and products.[1]

In the most recent publication on the Bolivian cinchonas, Standley's *The Rubiaceae of Bolivia*[2], all this information is ignored, with the result of so many errors that I can regard the publication only as a misfortune to *Cinchona* literature. On page 272 of this publication, occurs the following paragraph:

Cinchona officinalis L. Sp. Pl. 172. 1753. *C. lancifolia* Mutis, "Periódico de Santa Fe" 465. 1793. *C. nitida* R. & P. Fl. Peruv. 2:50. *pl. 191.* 1799. *C. lanceolata* R. & P. Fl. Peruv. 2:51. 1799. *C. Condaminea* Humb. & Bonpl. Pl. Aequin. 1:33. *pl. 10.* 1808. *C. macrocalyx* DC. Bibl. Univ. 41:150. 1829. *C. calisaya* Wedd. Ann. Sci. Nat. III. 10:6. 1848 (type from Bolivia). *C. amygdalifolia* Wedd., loc. cit. (described from Bolivia and Peru). *C. boliviana* Wedd., op. cit. 7. 1848 (type from

[1] Rusby, H. H. The cultivation of *Cinchona* in Bolivia. Pharm. Rec. 7: 305–308. 1887.

[2] Standley, Paul C. The Rubiaceae of Bolivia. Field Museum Nat. Hist. Bot. Ser. 7: 253–339. 1931.

Bolivia). *C. calisaya β calisaya vera* Wedd. Ann. Sci. Nat. III. 11:269. 1849. *C. calisaya β Josephiana* Wedd., loc. cit. *C. Condaminea δ lancifolia* Wedd., loc. cit. *C. lancifolia* var. *calisaya* Wedd. Ann. Sci. Nat. V. 12:35. 1869. *C. Forbesiana* Howard ex Wedd., op. cit. 36. 1869 (type from banks of Río Mapiri, Larecaja, at 300–1,200 m., *Forbes*). *C. calisaya* var. *microcarpa* Wedd., Ann. Sci. Nat. V. 11:361. 1869 (type from Valley of Coroico, Yungas). *C. Calisaya* var. *boliviana* Wedd., loc. cit. 1869. *C. Calisaya* var. *oblongifolia* Wedd., loc. cit. 1869 (type from Yungas). *C. Calisya* var. *pallida* Wedd., loc. cit. (type from Valley of Típuaní, Larecaja). *C. Josephiana Wedd.*, loc. cit. 1869. *C. Josephiana* subvar. *glabra* Wedd., loc. cit. 1869. *C. Josephiana* subvar. *pubescens* Wedd., loc. cit. 1869. *C. Josephiana* subvar. *discolor* Wedd., loc. cit. 1869 (type from Valley of Pelechuco). *C. Weddelliana* Kuntze, Monogr. *Cinchona* 29. 1878 (type from Bolivia). *C. Ledgereana* Moens ex Trimen, Journ. Bot. 19:323. 1881.

This is followed by the citation of thirty-two collections, all referred to *C. officinalis*, not one of which pertains to that species, which has never been found in Bolivia, either wild or under cultivation, nor in any of the extensive region that intervenes between Bolivia and the home of that species.

The number and variety of errors in these two paragraphs require classification into groups, before they can be dealt with individually. Omitting from present consideration *C. nitida*, *C. lanceolata*, *C. amygdalifolia*, *C. Boliviana*, and *C. Weddelliana*, regarding the specific identity of which there are reasonable grounds for difference of opinion, and *C. Forbesiana*, *C. Condaminea*, and *C. macrocalyx*, concerning the validity of which I have never been able to form an opinion, I submit the following confident opinions, as the result of my extensive study of the plants from different points of view, all agreeing in the conclusions which they indicate.

1. The resemblances between the narrow-leaved forms of *C. Calisaya* (which approach *C. Ledgeriana*) and *C. officinalis* are merely superficial, the two species being quite distinct in nature and habit.

2. *C. Calisaya* and *C. Ledgeriana* (which latter probably includes *C. Calisaya*, vars. *oblongifolia* and *microcarpa*) are certainly very close, and excuse the opinion that they are specifically identical. Nevertheless, under cultivation, they come true from seed and maintain their respective characteristics, and it seems preferable to treat them as two species.

3. There seem to be not even superficial characters to justify a careful student in connecting *C. Josephiana* with *C. Calisaya*, and this, in my opinion, relates to the examination of herbarium material as well as to field observations.

4. The '*C. Josephiana*, subvar. *pubescens*' cited is undoubtedly a hybrid of *C. Josephiana* and *C. ovata* (*C. pubescens* as named by Standley).

Discussing the above propositions, it is to be noted that few plants are so subject to variation between the leaves of their juvenile and mature

states as the cinchonas, a fact that will later be shown to have a bearing on the questions here discussed. There is little doubt that some of the proposed species and varieties have been based on these differences.

Of the thirty-two collections cited by Standley, ten are of my own collecting. All these were taken from cultivated trees of the plantation, and it is reasonably certain that twelve of the others are of the same origin. At the time of my stay there, no wild-grown plants of either *C. Calisaya* or *C. Ledgeriana* were obtainable, either in Mapiri or Yungas, although I offered liberal rewards to obtain them, and it seems rather inconsiderate for any botanist to venture on such radical views as those quoted above, regarding the identity of cultivated plants, without knowledge of the conditions of cultivation in the region concerned, a fact that will be more apparent when we consider other paragraphs of the paper under review.

The differences between *C. Calisaya* and *C. officinalis* are so marked, and of such great practical importance, and are so constant, that the cultivation of the latter for commercial purposes was early abandoned. A notable illustration is found in the abandoned *officinalis* plantations in Jamaica. These differences relate especially to the leaves, fruits, bark, and alkaloidal yield. The fruits of all forms of *C. Calisaya* and *C. Ledgeriana* are notable for the extreme degree of elastic curvature of the valves in dehiscence. Remaining attached at the top, and more or less at the base, the valves curve outward so that the pod, when dehiscence is complete, is often much broader than long. In *C. officinalis*, this curvature is notably slight.

The character of the leaves of *C. Calisaya* will be considered later, but it is a fact that those of *C. officinalis* are very different.

Standley says of the bark of *C. Calisaya* 'the trunk may be known by the periderm of the bark . . ., being always marked by longitudinal ridges or cracks, a characteristic remarked of no other tree of these forests, excepting one or two others of the same family.' This is his only reference to bark characteristics, attention to which has dominated the entire trade in cinchona bark previous to the establishment of testing by chemical assay. Not only was the species determined solely by the fissuring of the bark surface, but its maturity, and to a great extent its quality and value, were judged by this character. My bark specimens, now in the Museum of the Philadelphia College of Pharmacy, and my wood sections, at the New York College of Pharmacy, supply a perfect series of illustrations of this subject. It is safe to say that any purchaser of supposed *C. Calisaya* or *C. Ledgeriana* bark that possessed the exact appearance described above would lose most or all of his investment. The first and most conspicuous of the fissures appearing in the bark of these two species are circular, ap-

pearing at the nodes, where a pair of leaves had previously existed. Later, longitudinal ridges, starting as rows of warts, appear and still later crack open to form longitudinal fissures. A bark in this stage is not mature, does not contain its proper amount of quinine, and will not be accepted by a well-informed buyer, until its surface has become covered with irregular fine fissures. Because of the striking resemblance of this scaliness to that of the tarsus of a fowl, the natives have dubbed this '*pata de gallo*' bark, and this evidence of quality has been accepted and acted on generally in the bark trade. This appearance has never been seen in *C. officinalis* bark, except when it was the result of cross-pollination, which has occurred in the East Indies, though never in Bolivia, where, as stated, *C. officinalis* has not occurred. It is also true that the character of these fissures is definite and will never leave one in doubt if he is acquainted with them. Anyone visiting Sorata in the 1880's would have seen large warehouses where men were engaged in opening bark packages and examining every quill, accepting or rejecting them on the basis of the above appearance, although a certain percentage of immature bark, not having the chicken-leg appearance, would be accepted it not too thin.

The alkaloidal content of *C. officinalis* rarely exceeds 3.5 per cent, and almost three-fifths of it is quinine, while that of *C. Calisaya*, wild-grown, has reached nearly 6.5 per cent, four-fifths of it quinine. Selected bark from specially treated cultivated trees has been known to yield more than 15 per cent. The legal requirement is 5 per cent, which effectually excludes *C. officinalis* bark.

The reference of *C. Josephiana* to *C. Calisaya* is peculiarly in violation of the natural relations of the two. In 1849, Weddell published the opinion that a shrubby species of Bolivian cinchona pertained to the species *C. Calisaya*, and he named it var. *Josephiana*. This view was accepted by Markham, who based his collection of plants and seeds for introduction to cultivation in British India, on this theory. This error on Markham's part was not wholly excusable, since he had the benefit of the extensive knowledge of his associate, Charles Ledger, who had lived in the country and was thoroughly acquainted with the plants and their respective medicinal properties and commercial values. He insistently urged upon Markham the fact that the *C. Josephiana* bark was worthless and that, on botanical grounds, it was not closely related to *C. Calisaya*, and he did all in his power to induce Markham to confine his collection to the valuable species. However, the great bulk of seeds and plants carried away by Markham were of this species. It was several years after the introduction of the plants to India before the mistake was admitted, and vast plantations established in the meantime, in both British and Dutch India, were al-

most worthless, the result being the loss of hundreds of thousands of pounds sterling. In the meantime, Ledger, acting on his own responsibility, had secured a meagre supply of genuine *C. Calisaya* seeds, which he furnished to the British Government, and which were the means of saving cinchona culture from failure. One can imagine how those associated in the above events, or familiar with their history, will receive Standley's revival, in 1931, of this colossal *Calisaya-pajinal* blunder of 1849, abandoned by its author in 1869.

It is difficult to understand how so careful a botanist as Weddell could have taken the view that he did, and it is noteworthy that Ledger, who had known the plants much longer and more intimately, contested his view. Something is to be learned of this error from an examination of Weddell's types of *C. Calisaya*, which I was able to find at the home of Mr. Howard. These represent the narrow-leaved form of the species, and include only the leaves near the flowers, which are always narrower than those below. Most significant of all is the fact that in 1869 Weddell abandoned his former view, and named the plant *C. Josephiana*. He had, in the meantime, secured the benefit of the evidence afforded by cultivation, and his former view had met with universal condemnation.

Characteristic plants of *C. Calisaya* and *C. Josephiana* exhibit the following contrasts: *C. Josephiana* never grows in shaded places, but always on hot, dry, open hillsides, called *pajinals* by the people, whereas *C. Calisaya* is distinctly a forest tree. The home of *C. Josephiana* is at a much higher altitude. The altitudinal limitations of growth in this genus are decidedly narrow. When a plantation of *C. Calisaya* was allowed to extend too far up the mountainside, I have seen a very definite line of demarkation between the dead or dying trees above and the healthy ones below. It is not true, as stated by Standley, that *C. Calisaya* is sometimes shrubby. It is always a tree and will not flower until it has reached tree dimensions. *C. Josephiana*, on the other hand, never attains a height of more than ten feet, and is always of straggling habit. The bark of *C. Josephiana* is thin and never scaly, but is usually longitudinally wrinkled in drying, and never in the slightest degree resembles that of mature *C. Calisaya*. The leaves of *C. Josephiana* are usually more or less inequilateral or oblique. They never curve or wave in the wind, but are thick, rigid and coarse in texture. Those of *C. Calisaya* are conspicuously thin, of fine texture and silky appearance, and wave and curve in the wind, presenting a most beautiful appearance. Some of them being crimson on the lower surface, the effect is very characteristic. The difference in the relations of the secondary veins to the midrib are alone sufficient to distinguish the two. The flower panicles of *C. Calisaya* are large and many flowered, and droop

more or less, while those of *C. Josephiana* are stiffly erect and rigid. The flowers of the latter are larger and of different color. In the capsules, very conspicuous differences are found. Those of *C. Josephiana* are larger and relatively longer, and in dehiscence they separate at the base, but present little of the elastic curvature that is so characteristic of *C. Calisaya.* The bark of *C. Josephiana* is practically devoid of alkaloid. A cross-section of it, or even a pinch of its powder, will be instantly distinguished from that of *C. Calisaya.*

From page 273 of Standley's paper, I quote the following:

> **Cinchona pubescens** Vahl, Skrivt. Naturh. Selsk. 1:19. 1790. *C. hirsuta* R. & P. Fl. Peruv. 2:51. *pl. 192.* 1799. *C. purpurea* R. & P., op. cit. 52. *pl. 193.* 1799. *C. ovata* R. & P., op. cit. 52. *pl. 195.* 1799. *C. cordifolia* Mutis ex Willd. Ges. Naturf. Freund Berlin Mag. 1:117. 1807. *C. asperifolia* Wedd. Ann. Sci. Nat. III. 10:7. 1848 (type from Bolivia). *C. australis* Wedd., loc. cit. 1848 (described from Bolivia and Peru). *C. purpurascens* Wedd., loc. cit. 1848 (described from Bolivia and Peru). *C. Chomeliana* Wedd., op. cit. 9. 1848 (type from Bolivia). *C. pubescens* α *Pelletieriana* Wedd. Ann. Sci. Nat. III. 11:270. 1849. *C. succirubra* Pavon ex Klotzch, Abh. Akad. Berl. 1857:60. 1858.

This is followed by a citation of collections referred to this species, together with a description of the tree. I note first, that *C. asperifolia* is here given as a synonym of *C. pubescens,* whereas on page 271, it is maintained as a species. The reference of *C. ovata* to *C. pubescens* does not appear justifiable, in view of all the evidence. That of *C. purpurascens* and *C. purpurea* appears correct. That of *C. succirubra* will probably find no support anywhere. The author correctly describes the trunk of *C. ovata* as about 30 cm. in diameter, whereas *C. succirubra* is a very large tree, becoming nearly two yards in diameter. Because of its great size, it is now used in the Orient as a stock for grafting with *C. Ledgeriana.* The resulting tree acquires the dimensions of the host, while retaining the alkaloidal yield of the scion. It chanced that a small plantation of *C. succirubra* grew in Yungas, where I remained for some time, being the only one in Bolivia. I was thus able to compare it with *C. ovata,* the predominant species of northern Bolivia. The two have nothing in common, with the exception of their hairy leaves, and the trichomes of the two could not be mistaken for one another. Standley quotes early writers in saying that *C. ovata* yields a valuable bark, but this statement was erroneous from the beginning. This bark is the 'Cocola' of the collectors, and was valued only for fraudulent sale to ignorant buyers. It is very thin and not at all fissured, and contains scarcely any alkaloid, perhaps none when not of mixed parentage. The bark of *C. succirubra,* on the contrary, contains up to 6 per cent of alka-

loid, about two-fifths of it quinine. The bark of *C. succirubra* is heavily ridged, but never longitudinally fissured. These different types of bark are perfectly illustrated in the National Standard Dispensatory. In all my acquaintance with *C. ovata*, I have never seen a truly cordate leaf upon it, a character which Standley attributes to it. The base of this leaf is very abruptly contracted into a broad petiole, which is always more or less margined by the produced base.

In his citation of collections, Standley has reported those of the same origin, some under '*C. officinalis*' (*C. Calisaya*) and others under '*C. pubescens*' (*C. ovata*). These are all hybrids of *C. ovata* with other species, mostly with *C. Calisaya*.

This subject of hybridity has not been touched upon in the paper under discussion, yet it represents the most important condition that has affected cinchona culture in Bolivia. This condition has not been active in the East Indies, doubtless because those plantations are not surrounded and intruded upon by wild cinchonas of other species. In the production of seeds, Bolivian planters have been obliged to resort to unusual methods to prevent the access of foreign pollen, the seed trees being planted in remote situations, and protected in various ways, yet I have never seen these efforts to avoid cross pollination completely successful. The plantations are mostly stocked by contract, the contractor not being released and fully paid until the trees have reached an age when their specific identity can be verified. The seed-beds are culled as fast as the young hybrids can be identified, but the evidences of hybridity increase with age. After transfer to the plantation, the trees are allowed to grow to a height of about six feet, when arbitrators are appointed to determine the number of acceptable trees, and the contractor is paid for these only. The arbitrators walk between the rows, plucking a leaf from each tree. In the evening, these leaves are examined in joint session, and those are counted out which are not acceptable. Identification is based almost wholly on the presence of pubescence upon the leaves. The leaf of neither *C. Calisaya* nor *C. Ledgeriana* is ever hairy, except through cross pollination. Furthermore, the degree of pubescence has been found to agree closely with the character of the bark surface and its thickness, and with the alkaloidal yield. For this reason, the arbitrators do not reject leaves showing slight pubescence, and the bark buyers accord similar consideration to bark of reasonable thickness, even though not fully scaly. It is thus not only hybridity, but the degree of it that determines the decision.

The methods of pure science are not always as correct or conclusive as they are 'pure'. When pure science reaches conclusions that are directly opposed to the findings of legitimate commerce, it is up to the scientist to

ascertain the cause of the difference, and not to persist in declaring that two things which are quite different are the same!

The determination of hybridity between *C. Calisaya* and *C. Josephiana* is not so easy, because both are glabrous, but I feel very confident that some of the narrow-leaved species that have been described from Bolivia are based on such hybrids, and I have determined some of my own collections as products of this cross-pollination.

At the present time, the Bolivian plantations are abandoned, a result of cheap oriental competition. In the meantime, the wild trees have continued to propagate, and in 1921, I found the forests again filled with cinchona trees.

College of Pharmacy
Columbia University
New York

Propagation of Equisetum from sterile aerial shoots[1]

JOHN H. SCHAFFNER

The process of differentiation of the cells of a multicellular organism into somatic and reproductive systems has been an important problem for investigation and speculation for many years. Formerly, before the more exact knowledge of heredity was attained, the extreme speculations of Weismann largely dominated biological thought, especially on the zoological side. Even at the present time many treatises on general biology and genetics still present these purely speculative hypotheses, even though it is evident that they were developed before biologists had a proper knowledge of the reproductive process, or of karyokinesis and the reduction division.

The following experiments were undertaken for the double purpose of discovering how readily species of *Equisetum* could be propagated from aerial, sterile shoots and of obtaining evidence which would throw light on the problem of differentiation in relation to the reproduction of the individual.

The higher species of *Equisetum* are especially favorable plants for such a study of differentiation since they have highly dimorphic aerial, fertile and sterile shoots coming from the rhizome. In the lower species there is practically no difference between the sterile and fertile shoots, except that the latter have cones and the former have none, although they may develop cones later on lateral branches. The differentiation of the terminal buds of the aerial shoots takes place only near the end of their ontogenetic development. In the highest species, like *E. arvense* L., there is a tetramorphic development of the stem, besides the highly specialized tubercles on the rhizome. There is not only an extreme vegetative dimorphism between the sterile and fertile shoots, but the two kinds of shoots are differentiated as such at the very beginning of their development as lateral buds from the rhizome.

In the winter of 1929–30, Mr. Glenn W. Blaydes, of the Botany Department, called my attention to some aerial shoots of *E. praealtum* Raf. which had developed roots from the submerged nodes after being placed for some time in a jar of water. Accordingly this species of scouring-rush was used for the first experiment. Large shoots, both sterile and fertile, gathered in April, were cut off at the third or fourth internode above the ground and placed in jars of water with a little earth in the bottom. The

[1] Papers from the Department of Botany, The Ohio State University, No. 280.

submerged internodes promptly developed both roots and branches abundantly. In May they were planted in large flower pots and the pots were placed with their bottoms in water and left thus for the summer. By the latter part of September the cuttings had developed numerous rhizomes with many good-sized aerial shoots. Some of the rhizomes were over 3 ft. long and several of the new aerial shoots from them were $1\frac{1}{2}$ ft. high. The rhizomes grew around the inner walls of the pots about 2–3 inches from the surface.

It is thus an easy matter to grow plants of *E. praealtum* from the green sterile shoots. The aerial green branches which come from the nodes of the green shoots, as well as those which develop from the rhizome, show a very strong negative geotropism in this species. They are strongly differentiated from the rhizome in their physical reaction as well as morphologically. The aerial environment with exposure to light determines green determinate shoot development with vertical growth, while the dark underground environment determines black, indeterminate shoots, or rhizomes with horizontal growth, as well as green determinate shoots.

In the experiments with the cuttings, vertical green shoots were developed so long as the plants were in the water exposed to light, but when the cuttings were planted in earth the same internodes developed horizontal rhizomes. The differentiation of the original shoot into a characteristic, green, negatively geotropic system was not at all at the expense of the potentialities which produce black diageotropic systems. The differentiation is not at the expense of any hereditary potentialities possessed by the protoplast. Dedifferentiation is complete in either direction under a proper environmental change.

Having attained success in the vegetative propagation of *E. praealtum*, the same general methods were tried with the much more extremely specialized *E. arvense* L. This species has very extremely differentiated fertile and sterile shoots, and these shoots are differentiated from the very beginning of their development from the rhizome. Cuttings of aerial, green, sterile shoots were made October 4, 1930. These were comparatively small shoots and were in good condition for the time of the year, having not yet been frosted. A dozen shoots were placed in gallon crocks, filled about two-thirds with soil and sand. The ends of the shoots were stuck about half an inch into the soil and the crock was then filled nearly to the top with water. The water was changed from time to time in order to prevent the growth of fungi and bacteria on decaying branches. Eight of the cuttings produced new sprouts. After seven weeks, when they were well along the way in producing roots, the water was poured off, more soil added to cover the roots, and after this the soil was kept constantly water-soaked.

On December 1st, they were put into continuous light and continued to grow well, although very slowly, until March 12, when they were examined for rhizome development. All had produced rhizomes and tubercles and aerial green shoots from the rhizomes. The tubercles were packed with large starch grains and covered with long brown epidermal hairs. The branched aerial shoots were up to 8 inches high and some of the rhizomes were over 2 feet long, growing around the inner walls of the crocks. The rhizome produces no whorl branches but only sporadic main branches of two kinds from the nodes, aerial green shoots which grow against the direction of gravity and black rhizome branches which grow more or less horizontally under the ground.

The readiness with which new plants could be propagated from the main stems of the sterile aerial shoots of *E. arvense* suggested that new plants might also be produced from the small, highly specialized, 3- and 4-angled whorl branches. Accordingly, on May 25, 1931, such branchlets, each about 4–6 inches long, were planted about 2 inches deep in sandy soil, in large flower pots which were then placed in jars of water filled up to the level of the soil in the pots. The plant cuttings were kept in continuous light for three weeks, a 100 watt electric light bulb being used at night. Some of the branchlets began to develop lateral buds in ten days. There were 32 planted branchlets originally, and of these 23 sprouted side branchlets and roots and 17 of them survived and finally developed rhizomes. After three weeks the pots were transferred to a water tank with their bases about 3 inches in the water and received no more light at night.

The plants made a good growth during the summer, and by August 29 some had rhizomes up to 20 inches long with numerous roots and young aerial green shoots and were still growing vigorously. Some plants had also begun to produce tubercles. The original 3- and 4-angled branchlets remained unchanged in general character, except that they changed to a brown color where covered with the soil. Most of the original branchlets had in the meantime died off above ground, although the portion in the soil from which the rhizomes were developed was still alive.

These whorl branchlets of *Equisetum* represent the extreme vegetative differentiation of the sterile shoot, and do not produce semisterile cones, such as rarely occur on the main axis of the shoot. These tiny branchlets differentiated into determinate, annual, sterile shoots have thus not lost one particle of their original hereditary potentiality in the process of differentiation.

The branching system of *Equisetum* apparently evolved in the following manner: (1) stem not branching and completely indeterminate in growth; (2) sporadic lateral branching along with rhizome development,

the aerial branches developing as slowly determinate shoots at first and later evolving into promptly determinate shoots; (3) whorl branches evolved which were expressed only on the aerial shoots; (4) inhibition of the whorls on all the aerial shoots in some phylogenetic lines and inhibition of whorls only on the reproductive shoot in the highest series to which *E. arvense* belongs. Along with inhibition of branches in the *E. arvense* line came the extreme dimorphism, with loss of chlorophyll and a very short aerial life for the reproductive shoot. Somewhere along the evolutionary sequence, tubercle development was added. Thus a very complex and highly specialized hereditary reaction system is present in the cells and every protoplast in the plant has all the hereditary potentialities.

Now the problem arises as to how the process of differentiation of the various branch systems is brought about. It must be through the development of physiological states and gradients in relation with the environment. As stated in the beginning, many biologists apparently still have an abiding faith in the Weismannian speculations, although it is true that these hypotheses never made much headway among botanists. For it was well known that in the early embryonic development of the higher plants two very diverse structural and reaction systems, the root and the shoot, are developed. The reproductive continuity is normally through the shoot while the usual root never gives rise to reproductive cells, either in its phylogeny or in its ontogeny. It is purely a somatic system in its usual reactions. Yet very commonly the root can be made to produce a shoot which finally develops reproductive cells. This extreme differentiation of the body into root and shoot, therefore, was not brought about by a segregation of 'germplasm' and 'somatoplasm' nor by a change of 'germplasm' into 'somatoplasm.' The root cells have exactly the same kind of fundamental hereditary mechanism as the shoot cells and their descendants, the reproductive cells of one sort or another. There has been no change of 'germplasm' into 'somatoplasm' in the differentiation of the root into its peculiar structures, and physical and physiological reactions. The root has a 'germ track' as well as the shoot, although it was never in evidence during the geological ages. It is thus plain that, in such changes as root to shoot, or sterile, aerial shoot to rhizome, we have evidence that a plant or an animal soma may be 'born again' if only the right environment and conditions are supplied.

The Nussbaum-Weismann theory of heredity dates back to about the year 1880, when Nussbaum emphasized the genetic continuity of the germ cells from generation to generation, stating that during development the fertilized egg divides to produce on the one hand the cell material of the individual body and on the other the cells by which the characters of the

species are maintained. 'The fertilized egg, accordingly, divides into cells that constitute the individual and cells for the maintenance of the species.' This notion of the cells dividing into two types is the fundamental fallacy of the assumption. They sooner or later differentiate into distinct reaction units, but the reproductive cells are often differentiated as extremely or even more so than the ordinary body cells, and in both the higher plants and animals usually are not able to continue growth without a special stimulus or condition which is then supplied through conjugation or other means. The same confusion of analysis was formerly quite commonly expressed in relation to the reduction division, which was supposed to be a process by which the cell got rid of something that another mechanism might be supplied through fertilization.

In 1883 Weismann published the first of his speculative essays on heredity, and for many years Weismannism dominated various schools of speculative biological thought, although the whole structure was largely based on negative evidence and on the prevalent ignorance of the time. The terms, 'germplasm' and 'somatoplasm' can lead only to wrong conceptions of the ontogenetic process. Every protoplast that continues to function is a potential 'germ cell'. The common aphorism that 'an egg can produce a new hen or a new egg but a hen cannot produce a new hen or a new egg' is a fundamental fallacy based on an imperfect knowledge of living organisms in general and the nature of the differentiation process in particular.

Every one recognizes the fact that some cells may become so extremely differentiated that they do not return to the embryonic activity under ordinary or even the most extreme conditions, but the problem is one concerning the nature and degree of differentiation and the stimulation to dedifferentiation rather than the division or segregation of 'somatoplasm' from 'germplasm' by any process of change of the protoplast. Thus the study of plants like *E. arvense* may aid decidedly in eliminating such fantastic conceptions as 'germplasm', 'somatoplasm', and 'germ track' from the biologist's vocabulary.

COLUMBUS, OHIO

INDEX TO AMERICAN BOTANICAL LITERATURE
1927–1931

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

This index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of three cents for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the Index may be addressed to the Treasurer of the Torrey Club.

Allison, K. W. Mosses and their habitats in the Atiamuri District, New Zealand. Bryologist **34**: 29–37. My 1931.

Ames, O. *Davidia involucrata*. Arnold Arbor. Bull. Pop. Inf. **5**: 25–28. *illust.* 28 My 1931.

Anderson, E. G., & Emerson, R. A. Inheritance and linkage relations of chocolate pericarp in maize. Am. Nat. **65**: 253–257. My-Je 1931.

Anthony, H. E., Gleason, H. A., & Platt, R. R. The Pacaraima-Venezuela expedition. Geogr. Rev. **21**: 353–362. Jl 1931.

Armitage, E. The British Mycological Society. Bryologist **34**: 44–46. My 1931.

Ashe, W. W. *Polycodium*. Jour. Elisha Mitchell Sci. Soc. **46**: 196–213. Je 1931.

Eight new species and many new varieties are described.

Backeberg, C. *Cereus lanatus* und seine Verwandtschaft in Peru. Monats. Deutsch. Kakteen-Gesell, **3**: 155–159. *illust.* Jl 1931.

Ball, O. M. A contribution to the paleobotany of the Eocene of Texas. Bull. Agr. & Mech. Coll. Texas Prof. Paper IV. **2**: 1–173. *pl. 1–48.* 1 My 1931.

Barclay, B. D. Origin and development of tissues in stem of *Selaginella Wildenovii*. Bot. Gaz. **91**: 452–461. *f. 1–19.* 23 Je 1931.

Barrett, M. F. A field key to the genera of the wild and cultivated hardy trees of the northeastern United States and Canada. 1–40. Bloomfield, N. J., 1931.

Bates, J. C. A method for clearing leaves. Am. Nat. **65**: 288. Je 1931.

Belling, J. Chiasmas in flowering plants. Univ. California Publ. Bot. **16**: 311–338. *f. 1–11.* 2 Je 1931.

Benson, G. T. The trees and shrubs of western Oregon. Contr. Dudley Herb. Stanford Univ. **2**: 1–170. *illust.* 1930.

Blain, W. L. A list of diseases of economic plants in Alabama. Mycologia **23**: 300–304. 1 Jl 1931.

Blake, S. F. Six new South American species of *Verbesina*. Proc. Biol. Soc. Washington **44**: 79–85. 29 Je 1931.

Blomquist, H. L. A check list of the common mosses of Durham, N. C. and vicinity. Jour. Elisha Mitchell Sci. Soc. **46**: 170–178. Je 1931.

Blomquist, H. L. Genetics of mosses. Jour. Elisha Mitchell Sci. Soc. **46**: 267–275. Je 1931.
Abstract.

Bödeker, F. Etwas über *Mamillaria* (*Coryphantha*) *echinus* Engelm. Monats. Deutsch. Kakteen-Gesell. **3**: 136–137. *illust.* Je 1931.

Bödeker, F. *Coryphantha Georgii* Böd. spec. nova. Monats. Deutsch. Kakteen-Gesell. **3**: 163–164. Jl 1931.
A Mexican plant.

Boynton, K. R. *Crocus vernus*. Addisonia **16**: 75–76. *pl. 514.* "Mr" 9 Je 1931.

Boynton, K. R. *Eranthis Tubergenii*. Addisonia **16**: 77–78. *pl. 515.* "Mr" 9 Je 1931.

Boynton, K. R. *Scilla sibirica atrocoerulea*. Addisonia **16**: 79–80. *pl. 516.* "Mr" 9 Je 1931.

Braun, E. L. A hybrid *Lobelia*. Bot. Gaz. **91**: 462–463. 23 Je 1931.

Bravo, H. Cactaceas del Valle de Oaxaca. Cuatro especies nuevas del genero *Neomamillaria*. An. Inst. Biol. Univ. Mexico **2**: 117–126. *f. 1–12.* 1931.

Bravo, H. Contribucion al conocimiento de las Cactaceas de Tehuacan. 1–52. *f. 1–31.* Chapultepec. 1931.

Bravo, H. Contribucion al conocimiento de las Cactaceas de Mexico. Nota ac rca de la histologia del Peyote, *Lophophora Williamsii* Lemaire. An. Inst. Biol. Univ. Mexico **2**: 1–14. *f. 1–14.* 1931; 127–131. *f. 1.* 1931.

Bressman, E. N. The present status of breeding varieties of wheat resistant to bunt. Zentralb. Bakt. 2 Abt. **83**: 396–397. 8 Je 1931.

Bressman, E. N. Varietal resistance, physiologic specialization, and inheritance studies in bunt of wheat. Oregon Agr. Exp. Sta. Bull. 281: 1–44. *f. 1–9.* Je 1931.

Brink, R. A., & Senn, P. H. Heritable characters in maize. XI. Ragged, a dominant character, linked with A_1 Ts_4 and D_1. Jour. Heredity **22**: 155–161. *f. 11–13* My 1931.

Brinkman, A. H. Notes on some Canadian Hepatics. II. Bryologist **34**: 13–16. *pl. 1.* Mr 1931; 38–44. My 1931.

Brown, C. A. Plants observed on an excursion to Grand Isle, Louisiana. Bull. Torrey Club **57**: 509–513. *f. 1.* "O 1930" 30 Je 1931.

Brown, N. E. A new South African *Euphorbia*. Jour. Cactus & Succ. Soc. Am. **2**: 491. *illust.* Je 1931.

Buckett, H. W. Notes on the vegetation of Columbia, Mo. Am. Midl. Nat. **12**: 411–419. Jl 1931.

Buller, A. H. R. Researches on fungi. Vol. 4. Further observations on the *Coprini*, together with some investigations on social organisation and sex in the Hymenomycetes. i–xiii, 1–329. *f. 1–149.* Toronto, Longmans, Greene & Co., 1931.

Bultingaire, L. La flore et la faune des Colonies Francaises dans la collection des Vélins du muséum. La Terre er La Vie **5**: 295–304. *f. 1–6.* Je 1931.

Burkholder, P. R. Studies in Phytoplankton of the Cayuga Lake basin, New York. Bull. Buffalo Soc. Nat. Hist. **15**: 21–181. *f. 1–30.* 1931.

Chamberlain, G. C. Studies in fruit diseases. VI. Fire blight of pears and apples. Canada Dep. Agr. Pamph. 138: 1–10. *f. 1–3.* 1931.

Christophersen, E. Notes on *Joinvillea*. B. P. Bishop Mus. Occ. Papers **9**[12]: 1–7. *pl. 1.* 25 F 1931.

Christophersen, E. Vascular plants of Johnston and Wake Islands. B. P. Bishop Mus. Occ. Papers **9**[13]: 1–20. *pl. 1–5+f. 1–3.* My 1931.

Christophersen, E., & Caum, E. L. Vascular plants of the Leeward Islands, Hawaii. B. P. Bishop Mus. Bull. **81**: 1–41. *pl. 1–16+f. 1–3.* 1 Jl 1931.

Clark, Mrs. W. Flora of British Columbia. Vancouver Mus. & Art Notes **6**: 57–59. *illust.* Je 1931.

Cleland, R. E., & Blakeslee, A. F. Segmental interchange, the basis of chromosomal attachments in *Oenothera*. Cytologia **2**: 175–233. Je 1931.

Cockefair, E. A. The role of phosphorus in the metabolism of plants. Am. Jour. Bot. **18**: 582–597. "Jl" 19 Au 1931.

Collins, J. L., & Kerns, K. R. Genetic studies of the pineapple. I. A preliminary report upon the chromosome number and meiosis in seven pineapple varieties (*Annas sativas* Lindl.) and in *Bromelia pinguin* L. Jour. Heredity **22**: 139–142. *f. 2, 3.* My 1931.

Cook, M. T. The effect of mosaic on cell structure and chloroplasts. Jour. Dep. Agr. Puerto Rico **15**: 177–181. *pl. 9–13.* Ap 1931.

Cook, M. T. The leaf spot of tobacco; an after symptom of mosaic. Jour. Dep. Agr. Puerto Rico **15**: 183–187. *pl. 14.* Ap 1931.

Cook, M. T. New virus diseases of plants in Porto Rico. Jour. Dep. Agr. Puerto Rico **15**: 193–195. *pl. 15–19.* Ap 1931.

Cook, M. T. Some undescribed symptoms of mosaic in Porto Rican tobacco. Jour. Dep. Agr. Puerto Rico **15**: 189–191. Ap. 1931.

Cooper, D. C., & Brink, R. A. Cytological evidence for segmental interchange between non-homologous chromosomes in maize. Proc. Nat. Acad. Sci. **17**: 334–338. *f. 1–5.* 15 Je 1931.

Cooper, W. S. The layering habit in Sitka spruce and the two western hemlocks. Bot. Gaz. **91**: 441–451. *f. 1–4.* 23 Je 1931.

Cory, V. L. A new *Selenia* from the Edwards Plateau of Texas. Rhodora **33**: 142–144. 1 Je 1931.

Couch, J. N. *Micromyces zygogonii* Dang., parasitic on *Spirogyra*. Jour. Elisha Mitchell Sci. Soc. **46**: 231–239. *pl. 16–18.* Je 1931.

Couch, J. N. Observations on some species of water molds connecting *Achlya* and *Dictyuchus*. Jour. Elisha Mitchell Sci. Soc. **46**: 225–230. *pl. 15.* Je 1931.

Crist, J. W., & Batjer, L. P. The stone cells of pear fruits, especially the Kieffer pear. Michigan Agr. Exp. Sta. Tech. Bull. 113: 1–55. *f. 1–21.* My 1931.

Darrow, G. M. European blackberry seedlings and hybrids in the Pacific northwest. Jour. Heredity **22**: 143–146. *f. 4, 5.* My 1931.

Davis, B. M. Some attempts to obtain haploids from *Oenothera Lamarckiana*. Am. Nat. **65**: 233–242. My-Je 1931.

Dole, W. H. Notes on a New Jersey fern garden I. Am. Fern. Jour. **21**: 1–10. *pl. 1–3.* Ja-Mr 1931; II. 57–62. *pl. 4–6.* Je 1931.

East, E. M. Immunity to sugar cane mosaic acquired by the host. Proc. Nat. Acad. Sci. **17**: 331–334. 15 Je 1931.

Eaton, M. E. *Galanthus Fosteri.* Addisonia **16**: 73–74. *pl. 513.* "Mr" 9 Je 1931.

Eaton, M. E. *Primula veris* L. Addisonia **16**: 81–82. *pl. 517.* "Mr" 9 Je 1931.

Elze, D. L. The relation between insect and virus as shown in potato leaf roll, and a classification of viroses based on this relation. Phytopathology **21**: 675–686. Je 1931.

Emerson, S. The inheritance of certain characters in *Oenothera* hybrids of different chromosome configurations. Genetics **16**: 325–348. *pl. 1–4.* Jl 1931.

Emmons, C. W. *Cicinnobolus Cesatii*, a study in host-parasite relationships. Bull. Torrey Club **57**: 421–441. *pl. 24–26.* "O 1930" 30 Je 1931.

Erlanson, E. W. Chromosome organization in *Rosa*. Cytologia **2**: 256–282. *f. 1–33.* Je 1931.

Eyster, W. H. Heritable characters of maize. Male sterility. Jour. Heredity **22**: 99–102. *f. 8, 9.* Mr 1931; XXXIX. Male sterile- 3. 117–119. *f. 7, 8.* Ap 1931.

Flemming, C. E., Miller, M. R., & Vawter, L. R. The fitweed (*Caponoides caseana*) a poisonous range plant of the northern Sierra Nevada Mountains. Nevada Agr. Exp. Sta. Bull. 121: 1–28. *illust.* Ap 1931.

Fisher, E. L. When southeast Alaska blooms. Some of the flowers of the southern coast. Nature Mag. **18**: 29–32. *illust.* Jl 1931.

Frick, G. A. *Bergerocactus Emoryi* (Engelm.) Britt. & Rose. Northern extension. Jour. Cactus & Succ. Soc. Am. **2**: 490. *illust.* Je 1931.

Frick, G. A. De ontdekking van *Euphorbia Frickiana*. Succulenta **13**: 135–136. *illust.* Jl 1931.

Fuller, A. M. Conservation of plant life in Arizona and California. Year Book Publ. Mus. Milwaukee **9**: 243–254. *f. 175–180.* 15 My 1931.

Fuller, A. M. Observations of a botanist in the southwest. Year Book Publ. Mus. Milwaukee **9**: 26–36. *f. 19–27.* 15 My 1931.

Garber, R. J. Inbreeding with particular reference to maize. Jour. Am. Soc. Agron. **23**: 534–548. Jl 1931.

Gedroiz, K. K. Exchangeable cations of the soil and the plant: I. Relation of plant to certain cations fully saturating the soil exchange capacity. Soil. Sci. **32**: 51–63. Jl 1931.

Gill, T. Tropical forests of the Caribbean. i–xix, 1–318. *illust.* Trop. Plant Res. Found. 1931.

Grout, A. J. Moss flora of North America north of Mexico. 3^1: 1–62. *pl. 1–14.* S 1928; 3^2: 1–62. *pl. 1–14.* S 1928; 63–114. *pl. 15–29.* Je 1931.

Gushee, H. W. Blooming dates of flowers. Gard. Chron. Am. **35**: 261. Jl 1931.

Haber, E. S. Acidity and color changes in tomatoes under various storage temperatures. Iowa St. Coll. Jour. Sci. **5**: 171–184. Ap 1931.

Halperin, M. The occurrence of normal (unproliferated) florets in *Poa bulbosa* in the United States. Jour. Am. Soc. Agron. **23**: 511–515. *f. 1–5.* Jl 1931.

Harrison, T. G. *Symplocos tinctoria Ashei* a new dyebush from the southern mountains. Jour. Elisha Mitchell Sci. Soc. **46**: 218–220. Je 1931.

Hartman, H. A preliminary report on Anjou scald and its control. Oregon Agr. Exp. Sta. Bull. 280: 1–8. *f. 1, 2.* Je 1931.

Harvey, E. M. A preliminary report on the vegetative growth of okra (*Hibiscus esculentus* Linn.) in relation to the production of varying amounts of reproductive tissue. Oregon Agr. Exp. Sta. Bull. 284: 1–19. *f. 1–8.* Je 1931.

Harvey, R. B. The action of toxic agents used in eradication of noxious plants. Jour. Am. Soc. Agron. **23**: 481–489. *f. 1–4.* Je 1931.

Hellmayr, C. E., & Hellmayr, K. J. An overlooked species of coral-root from the Rocky Mountains. Rhodora **33**: 133–135. 1 Je 1931.

Hey, G. L., & Carter, J. E. The effect of ultra-violet light radiations on the vegetative growth of wheat seedlings and their infection by *Erysiphe graminis.* Phytopathology **21**: 695–699. Je 1931.

Higgins, E. B. Our native cacti. i–vii, 1–170. *illust.* New York, A. T. de La Mare Co., 1931.

Himmelbaur, W. Drogenpflanzen. I. Alkaloid-Drogenpflanzen. Pflanzenareale **3**: 19–25. *pl. 21–30.* 1931.

Hitchcock, A. S. A botanical visit to south and east Africa. Explor. & Field Work Smithsonian Inst. **1930**: 113–122. *f. 96–107.* 1931.

Hitchcock, A. S. Grasses of Canton and vicinity. Lingnan Sci. Jour. **7**: 177–265. *pl. 9–11.* "Je 1929" My 1931.

Holton, C. S. The relation of physiologic specialization in *Tilletia* to recent epiphytotics of bunt in Durum and Marquis wheats. Phytopathology **21**: 687–694. *f. 1.* Je 1931.

Horne, W. T. The avocado sun-blotch disease. Month. Bull. Dep. Agr. California **20**: 447–454. *f. 82–85.* Jl 1931.

Huff, R. Gladiolus forms and types. Flor. Exch. **77**: 33. *f. A. B.* 6 Je 1931.

Hutchinson, J. B. The genetics of cotton. Part IV. The inheritance of corolla color and petal size in Asiatic cottons. Jour. Genetics **24**: 325–353. *pl. 10.* 23 Jl 1931.

Immer, F. R. & Christensen, J. J. Further studies on reaction of corn to smut and effect of smut on yield. Phytopathology **21**: 661–674. Je 1931.

Isbell, C. L. Regeneration in leaf cuttings of *Ipomoea batatas*. Bot. Gaz. **91**: 411–425. *f. 1–19.* 23 Je 1931.

Johansen, D. A. *Ludwigia Jussiena*. Desert **3**: 21, 23. *illust.* Je 1931.

Johansen, D. A. Movements in cacti. Jour. Cactus & Succ. Soc. Am. **2**: 494–495. *illust.* Je 1931.

Jorgensen, L. R. Brown midrib in maize and its linkage relations. Jour. Am. Soc. Agron. **23**: 549–557. Jl 1931.

Juliano, J. B. Floral morphology of *Lyonothamnus floribundus*. Bot. Gaz. **91**: 426–440. *f. 1–29.* 23 Je 1931.

Kaufmann, B. P. Chromonemata in somatic and meiotic mitoses. Am. Nat. **65**: 280–283. My-Je 1931.

Karling, J. S. Studies in the Chytridiales. V. A further study of species of the genus *Entophlyctis*. Am. Jour. Bot. **18**: 443–464. *pl. 35–38.* "Je" 14 Jl 1931; VI. The occurrence and life history of a new species of *Cladochytrium* in cells of *Eriocaulon septangulare*. 526–557. *pl. 42–44.* "Jl" 19 Au 1931.

Karper, R. E., & Connor, A. B. Inheritance of chlorophyll characters in sorghum. Genetics **16**: 291–308. *f. 1, 2.* Jl 1931.

Kelley, A. P. Studies in Iowa plant-life. I. The genera *Equisetum*, *Quercus*, *Amelanchier* and *Fraxinus* in the Okoboji flora. Univ. Iowa Stud. Bot. **13**: 11–19. 15 Je 1931.

Kelley, A. P. The water supplying capacity of prairie soil, as indicated by observations on a virgin prairie in northwestern Iowa. Univ. Iowa Stud. Bot. **13**: 20–31. 15 Je 1931.

Kiesselbach, T. A., & Culbertson, J. O. An analysis of the effect of *Diplodia* infection and treatment of seed corn. Jour. Agr. Res. **42**: 723–749. *f. 1.* 1 Je 1931.

King, C. J., Loomis, H. F., & Hope, C. Studies on sclerotia and mycelial strands of the cotton root-rot fungus. Jour. Agr. Res. **42**: 827–840. *f. 1–4.* 15 Je 1931.

Kolk, L. A. Relation of host and pathogen in the oat smut, *Ustilago Avenae*. Bull. Torrey Club **57**: 448–507. *pl. 27–30.* "O 1930" 30 Je 1931.

Kupper, W. *Cephalocereus Guntheri* n. sp. Monats. Deutsch. Kakteen-Gesell. **3**: 159–162. *illust.* Jl 1931.
A plant from Bolivia.

Lampe, L. A microchemical and morphological study of the developing endosperm of maize. Bot. Gaz. **91**: 337–376. *pl. 3+f. 10–16.* 23 Je 1931.

Ledgerwood, M. The American bottom and the characteristic plants of the region. Missouri Bot. Gard. Bull. **19**: 99–109. Je 1931.

Lehman, S. G. Observations and experiments relating to the bacterial pustule disease of soybean. Jour. Elisha Mitchell Sci. Soc. **46:** 179–189. Je 1931.

Lehman, S. G. Powdery mildew of soybean. Jour. Elisha Mitchell Sci. Soc. **46:** 190–195. *f. 1–3.* Jl 1931.

Lindstrom, E. W., & Koos, K. Cyto-genetic investigations of a haploid tomato and its diploid and tetraploid progeny. Am. Jour. Bot. **18:** 398–410. *pl. 32–34.* "Je" 14 Jl 1931.

McClelland, C. K., & Neely, J. W. The order, rate, and regularity of blooming in the cotton plant. Jour. Agr. Res. **42:** 751–763. *f. 1–4.* 1 Je 1931.

McIndoe, K. G. The inheritance of the reaction of maize to *Gibberella Saubinetti.* Phytopathology **21:** 615–639. *f. 1–6.* Je 1931.

McKay, J. W. Chromosome studies in the Cucurbitaceae. Univ. California Publ. Bot. **16:** 339–350. *f. 1–30.* 19 Je 1931.

McKinney, H. H. Differentiation of viruses causing green and yellow mosaics of wheat. Science II. **73:** 650–651. 12 Je 1931.

McLean, R. R. Insect pests and plant diseases of the Avocado in California. Month. Bull. Dep. Agr. California **20:** 441–446. *f. 81.* Jl 1931.

MacMillan, H. G. Turgescence and rupture of potato tuber. Phytopathology **21:** 701–703. Je 1931.

McNair, J. B. Some properties of alkaloids in relation to climate of habitat. Am. Jour. Bot. **18:** 416–423. *f. 1–3.* "Je" 14 Jl 1931.

McNair, J. B. Some properties of plant waxes in relation to climate of habitat. Am. Jour. Bot. **18:** 518–525. "Jl" 19 Au 1931.

Macoun, W. T. Some new lilac hybrids. Nat. Hort. Mag. **10:** 185–190. *illust.* Jl 1931.

Malhotra, R. C. Some unusual observations of corn seeds during germination. Am. Midl. Nat. **12:** 420–421. Jl 1931.

Markley, K. S., & Sando, C. E. Progressive changes in the wax-like coating on the surface of the apple during growth and storage. Jour. Agr. Res. **42:** 705–722. *f. 1–3.* 1 Je 1931.

Martin, G. W. Notes on Iowa fungi, 1929–30. Univ. Iowa Stud. Bot. **13:** 3–10. *pl. 1.* 15 Je 1931.

Martyn, E. B. Notes on some diseases of local economic plants and their relation to environment. Agr. Jour. British Guiana **4:** 95–100. *f. 1–4.* Je 1931.

Merrill, E. D. Urusvati brings America new botanical treasures. Jour. Urusvati Himal. Res. Inst. **1:** 87–88. Jl 1931.

Mayer, G. P. A. Narcissi. Their history and development. Gard. Chron. Am. **35:** 228, 241. Je 1931.

Morse, E. E. The spined puffball. Nature Mag. **17:** 382–383. *illust.* 1931.

Navashin, M. A preliminary report on some chromosome alterations by x-rays in *Crepis*. Am. Nat. **65:** 242–252. *f. 1.* My-Je 1931.

Nelson, A. Rocky Mountain herbarium studies I. Am. Jour. Bot. **18:** 431–442. "Je" 14 Jl 1931.

Fourteen new species in various genera are described.

Pearson, W. H. Notes on a collection of Hepaticae from Jamaica. Ann. Bryol. **4:** 95–112. *pl. 1, 2.* 1931.

Includes descriptions of eight new species in various genera.

Peattie, D. C. Flora of the Tryon region. VI. Daisy family (Compositae). List of new names published, errata, summary. Jour. Elisha Mitchell Sci. Soc. **46:** 129–160. Je 1931.

Peckham, E. A. S. *Hyacinthus azureus.* Addisonia **16:** 83–84. *pl. 518.* "Mr" 9 Je 1931.

Peckham, E. A. S. *Leucojum vernum carpathicum.* Addisonia **16:** 85–86. *pl. 519.* "Mr" 9 Je 1931.

Pickett, F. L. Notes on xerophytic ferns. Am. Fern Jour. **21:** 49–57. Je 1931.

Pitman, H. Bryology notes from Panther Pond, Raymond, Maine, U.S.A. Bryologist **34:** 37–38. My 1931.

Pulley, H. C. Ammonification of nitrogenous substances by pure cultures of microorganisms. Jour. Agr. Res. **42:** 791–800. *f. 1, 2.* 1 Je 1931.

Purdy, C. *Erythronium.* Nat. Hort. Mag. **10:** 173–185. *illust.* Jl 1931.

Quanjer, H. M. The methods of classification of plant viruses, and an attempt to classify and name potato viroses. Phytopathology **21:** 577–613. *f. 1–8.* Je 1931.

Ramsey, G. B., & Bailey, A. A. Tomato late-blight rot, a serious transit and market disease. U. S. Dep. Agr. Circ. 169: 1–10. *f. 1–6.* Jl 1931.

Reed, G. M. Hybrids of *Iris fulva* and *Iris foliosa.* Brooklyn Bot. Gard. Rec. **20:** 243–253. *pl. 1.* Jl 1931.

Rigg, G. B., & Harrar, E. S. The root systems of trees growing in *Sphagnum.* Am. Jour. Bot. **18:** 391–397. *f. 1–4.* "Je" 14 Jl 1931.

Robbins, C. A. Cladonias collected by S. F. Blake in the western United States. Rhodora **33:** 135–139. *pl. 209.* 1 Je 1931.

Rugg, H. G. A glimpse of Iceland. Am. Fern Jour. **21:** 71–73. Je 1931.

Schaffner, J. H. The fluctuation curve of sex reversal in staminate hemp plants induced by photoperiodicity. Am. Jour. Bot. **18:** 424–430. *f.* 1. "Je" 14 Jl 1931.

Schaffner, J. H. Injurious fungus parasite of *Equisetum*. Am. Fern Jour. **21:** 75. 20 Je 1931.

Schmidt, O. C. Beiträge zur Kenntnis der Aristolochiaceen. II. Zwei neue Aristolochia-Arten aus Bolivien. Repert. Spec. Nov. **27:** 292–293. 20 F 1930.

Schwarz, H. Die wichtigeren Feinde der Douglasii in Nordamerika. Zeit. Pflanzenkrank. & Pflanzensch. **41:** 266–268. Je 1931.

Seaver, F. J. Photographs and descriptions of cup-fungi. XIV. A new genus. Mycologia **23:** 247–251. *pl. 23–24.* 1 Jl 1931.

Chloroscypha Jacksoni, gen. et sp. nov.

Seifritz, W. The structure of protoplasm. Science II. **73:** 648–649. *f. 1.* 12 Je 1931.

Setchell, W. A., & Gardner, N. L. Marine algae of the Revillagigedo Islands expedition in 1925. Proc. California Acad. Sci. **19:** 109–215. *pl. 4–15.* 30 D 1930.

Shamel, A. D., Pomeroy, C. S., & Harmon, F. N. Bud variation in Bartlett pear trees. Jour. Heredity **22:** 81–89. *f. 1–4.* Mr 1931.

Sharp, A. J. *Trichomanes Petersii* A. Gray in Tennessee. Am. Fern Jour. **21:** 75–76. 20 Je 1931.

Sideris, C. P. Taxonomic studies in the family Pythiaceae. I. *Nematosporangium*. Mycologia **23:** 252–295. *f. 1–12.* 1 Jl 1931.

Eight new species are described.

Sideris, C. P., & Paxton, G. E. Pathological, histological, and symptomatological studies on pineapple root rots. Am. Jour. Bot. **18:** 465–498. *f. 1–25.* "Je" 14 Jl 1931.

Small, J. K. Bartram's *Ixia* collection rediscovered. Jour. N. Y. Bot. Gard. **32:** 155–161. *f. 1, 2.* Jl 1931.

Small, J. K. The Cypress, southern remnant of a northern fossil type. Jour. N. Y. Bot. Gard. **32:** 125–135. *f. 1–5.* Je 1931.

Small, J. K. *Iris verna*. Addisonia **16:** 87–88. *pl. 520.* "Mr" 9 Je 1931.

Smith, C. M. Development of *Dionaea muscipula*. II. Germination of seed and development of seedling to maturity. Bot. Gaz. **91:** 377–394. *f. 1–36.* 23 Je 1931.

Smith, D. C., & Bressman, E. N. Susceptibility of Markton and

other varieties of oats to covered smut (*Ustilago levis*). Jour. Am. Soc. Agron. **23**: 465–468. Je 1931.

Smith, F., Dustman, R. B., & Shull, C. A. Ascent of sap in plants. Bot. Gaz. **91**: 395–410. *f. 1.* 23 Je 1931.

Smith, H. H. Mushrooms of the Milwaukee region. Milwaukee Publ. Mus. Field Guide Bot. **1**: 1–87. *f. 1–184.* Je 1931.

Smith, O. Characteristics associated with abortion and intersexual flowers in the eggplant. Jour. Agr. Res. **43**: 83–94. *pl. 1–3+f. 1.* 1 Jl 1931.

Southcott, M. Blooms of Newfoundland. Nature Mag. **17**: 384–386. *illust.* Je 1931.

Sprague, H. B., & Marrero, J. F. The effect of various sources of organic matter on the properties of soil as determined by physical measurements and plant growth. Soil Sci. **32**: 35–48. *pl. 1.* Jl 1931.

Standley, P. C. The Rubiaceae of Bolivia. Field. Mus. Nat. Hist. Publ. Bot. **7**: 255–339. 16 Je 1931.

Standley, P. C. Studies of American plants. IV. Field Mus. Nat. Hist. Bot. **8**: 133–236. 22 O 1930; V. 295–398. 25 Je 1931.

Stanford, E. E. The plant with a personality. The Jimson, drug, deliriant, vagabond and enemy. Nature Mag. **17**: 378–381. *illust.* Je 1931.

Steere, W. C. Notes on the mosses of southern Michigan. Bryologist **34**: 1–5. "Ja" Je 1931.

Stevens, F. L., & Mendiola, V. B. Aecioid short cycle rusts of the Philippine Islands. Phillipine Agr. **20**: 3–17. *f. 1–9.* Je 1931.

Stevens, O. A. North Dakota weeds. N. Dakota Agr. Exp. Sta. Bull. 243: 1–58. *f. 1–59.* D 1930. (Revised edition.)

Stewart, G., & Bischoff, B. K. Correlated inheritance in a cross (Sevier×Dicklow)×Dicklow wheats. Jour. Agr. Res. **42**: 775–790. *f. 1–3.* 1 Je 1931.

Stewart, G., & Judd, B. I. Inheritance of awns in a Kota×hard Federation cross. Jour. Am. Soc. Agron. **23**: 455–464. *f. 1–4.* Je 1931.

Summerhayes, V. S. *Lycaste suaveolens.* Curt. Bot. Mag. **154**: *pl. 9231.* 25 Ap 1931.

A plant from Central America.

Swallen, J. R. The grass genus *Amphibromus.* Am. Jour. Bot. **18**: 411–415. "Je" 14 Jl 1931.

Swanson, A. F., & Parker, J. H. Inheritance of smut resistance and juiciness of stalk in the sorghum cross, Red Amber × Feterita. Jour. Heredity **22**: 51–56. *f. 7–9.* F 1931.

Swift, M. E. "Crazed" crockery and other strange habitats of moulds. Jour. N. Y. Bot. Gard. **32:** 149–154. *f. 1, 2.* Jl 1931.

Tang, P. An experimental study of the germination of wheat seed under water, as related to temperature and aeration. Plant Physiol. **6:** 203–248. *f. 1–5.* Ap 1931.

Tang, P. Temperature characteristics for the oxygen consumption of germinating seeds of *Lupinus albus* and *Zea Mays.* Jour. Gen. Physiol. **14:** 631–641. *f. 1–6.* 20 My 1931.

Taylor, W. R. Chromosome studies on *Gasteria.* III. Chromosome structure during microsporogenesis and the postmeiotic mitosis. Am. Jour. Bot. **18:** 367–386. *pl. 27–30+f. 1–12.* 27 My 1931.

Thompson, W. P. Cytology and genetics of crosses between fourteen- and seven-chromosome species of wheat. Genetics **16:** 309–324. *f. 1–8.* Jl 1931.

Thornberry, H. H., & Anderson, H. W. A bacterial disease of barberry caused by *Phytomonas Berberidis,* n. sp. Jour. Agr. Res. **43:** 29–36. *f. 1–5.* 1 Jl 1931.

Throne, A. L. Recent contributions to the flora of Wisconsin. Rhodora **33:** 139–140. 1 Je 1931.

Tilden, J. E. The marine and freshwater algae of China. Lingnan Sci. Jour. **7:** 349–398. *pl. 13.* "Je 1929" Mr 1931.

Tilden, J. E., & Fessenden, A. P. *Bactrophora irregularis,* a new brown alga from Australia. Bull. Torrey Club **57:** 381–388. *pl. 20, 21.* "Je 1930" 20 Je 1931.

Tisdale, W. B., & Wadkins, R. F. Brown spot of tobacco caused by *Alternaria longipes* (E. & E.) n. comb. Phytopathology **21:** 641–660. *f. 1–5.* Je 1931.

Toro, R. A. Contribucion a la flora de Antioquia. Rev. Soc. Cien. Nat. Colombiana **20:** 20–32. Mr 1931; 57–64. My 1931.

Toro, R. A. Una contribución a nuestro conocimiento de la flora de San Andrés y Providencia. II. Rev. Soc. Colombiana Cien. Nat. **19:** 56–58. My 1930.

Torrey, G. S. *Drosera rotundifolia,* var. *comosa* in Connecticut. Rhodora **33:** 144 1 Je 1931.

Torrey, R. H. Plant life around New York as studied by the Torrey Botanical Club. Jour. N. Y. Bot. Gard. **32:** 141–145. Je 1931.

Truman, H. V. Pollen of *Sparganium americanum* and *S. androcladum.* Rhodora **33:** 141–142. 1 Je 1931.

Wailes, G. H. Protozoa and algae, Mount Ferguson, B. C. Vancouver Mus. & Art Notes **5:** 160–165. *f. 1–47.* D 1930; **6:** 72–75. Je 1931.

Walther, E. Century plants. Jour. Cactus & Succ. Soc. Am. **2:** 487–489. *f. 1–4.* Je 1931.

Walther, E. Genus *Pachyphytum.* Jour. Cactus & Succ. Soc. Am. **3:** 9–13. *f. 9–16.* Jl 1931.

Waterman, W. G. Ecological relations of plant communities. Jour. N. Y. Bot. Gard. **32:** 145–147. Je 1931.

Weber, G. F. Occurrence and habitat of *Cordyceps agariciformia* (Bolt.) Seaver in Florida. Jour. Elisha Mitchell Sci. Soc. **46:** 221–224. *pl. 13, 14.* Je 1931.

Werdermann, E. Über *Echinopsis caespitosa* I. A. Purp. Monats. Deutsch. Kakteen-Gesell. **3:** 165–167. *illust.* Jl 1931.

West, J. Dew flowers. Jour. Cactus & Succ. Soc. Am. **2:** 493. *illust.* Je 1931.

Wilde, E. I. Studies of the genus *Delphinium.* Cornell Agr. Exp. Sta. Bull. 519: 1–107. *f. 1–18.* Ap 1931.

Williams, R. O. Flora of Trinidad and Tobago. Rosales (pars). Dep. Agr. Trinidad & Tobago **1:** 97–308. 1931.

Williams, R. S. *Homalia Sharpii* sp. nov. Bryologist **34:** 20. *pl. 2.* "Mr" 15 Je 1931.

Wilson, J. D., & Runnels, H. A. Bordeaux mixture as a factor increasing drouth injury. Phytopathology **21:** 729–738. *f. 1, 2.* Jl 1931.

Winter, H. De expeditie van Friedrich Ritter naar Neder-Californie en langs de zeekust van Californie. Succulenta **13:** 85–90. *f. 1–4.* My 1931.

Wodehouse, R. P. The origin of the six-furrowed configuration of *Dahlia* pollen grains. Bull. Torrey Club **57:** 371–380. *pl. 19.* "Je 1930" 20 Je 1931.

Wolf, C. B. Plants indigenous to Rancho Santa Ana. Rancho Santa Ana Bot. Gard. Rep. **1:** 17–21. Je 1931.

Wright, E. The effect of high temperatures on seed germination. Jour. Forest. **29:** 679–687. My 1931.

Wright, J., & Leach, R. *Fusarium* wilt disease of Sunn hemp. I. Jour. Imp. Coll. Trop. Agr. **8:** 151–160. *f. 1+charts 1–5.* Je 1931.

Yamada, Y. Notes on *Laurencia,* with special reference to the Japanese species. Univ. California Publ. Bot. **16:** 185–310. *pl. 1–30+f. 1–20.* 26 Je 1931.

Zahlbruchner, A. Catalogus lichenum universalis **7:** 321–480. Leipzig. 1931.

Zundel, G. L. Notes on new species of Ustilaginales. Mycologia **23:** 296–299. 1 Jl 1931.

Ten new species in various genera are described.

INDEX TO VOLUME 58

New names and the final members of new combinations are in **bold face type**. The plant names of the report of the Tyler-Duida Expedition (pages 277–506) are to be found in a separate index beginning on page 555.

INDEX TO LATIN NAMES OF THE REPORT OF THE TYLER-DUIDA EXPEDITION

New names and the final members of new combinations are in **bold face** type.